REPORT JTCG/AS-94-D-004

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JOINT TECHNICAL COORDINATING GROUP ON AIRCRAFT SURVIVABILITY

BIBLIOGRAPHY OF JOINT AIRCRAFT SURVIVABILITY REPORTS AND RELATED DOCUMENTS

JULY 1994

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ASI Systems International

for the
Joint Technical Coordinating Group
on Aircraft Survivability (JTCG/AS)
Central Office

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REPORT JTCG/AS-94-D-004

JOINT TECHNICAL COORDINATING GROUP ON AIRCRAFT SURVIVABILITY (JTCG/AS)

BIBLIOGRAPHY OF JOINT AIRCRAFT SURVIVABILITY REPORTS AND RELATED DOCUMENTS

JULY 1994

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1. JTCG/AS Organization Chart 3

INTRODUCTION AND INSTRUCTIONS

INTRODUCTION

This bibliography is published by the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) Central Office. The JTCG/AS is chartered by the Joint Aeronautical Commanders Group (JACG). The JTCG/AS organization is depicted on page 3. The purpose of this document is to provide a listing of technical reports which have been published under the auspices of the JTCG/AS. This bibliography is organized by sections which contain publications produced by the three principal subgroups, Susceptability Reduction, Vulnerability Reduction and Survivability Methodology. These sections are followed by a section containing Administrative and Group support publications and another section containing publications pertaining to Aircraft Battle Damage Repair. As a final section documents pertaining to aircraft survivability but not funded by the JTCG/AS are included. Each section has it's own table of contents. The document is indexed by Report number and title.

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Any documentation effort funded wholly or in part with JTCG/AS funding falls within the publication guidelines provided herein. They are:

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2. Report number assignments are made by the JTCG/AS Central Office. Logos are also available from the Central Office (phone number (703) 325-0165).

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6. Cognizant engineers will fax a copy of the SF 298 to the Central Office upon document publication (fax number (703) 325-0178) and will also ensure that the JTCG/AS Central Office is informed when DTIC Accession numbers (AD #s) or SURVIAC File numbers are assigned to their publications.

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   Cameron Station
   Alexandria, VA 22314
   Attn: DTIC-TSR

2. Reports not having a DTIC accession number:
   Submit DTIC Form 55 through channels to:

   SURVIAC
   WL/FIVS/SURVIAC
   Wright-Patterson AFB, OH 45433

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Due to the nature of most of the technical reports produced by the JTCG/AS, a widespread distribution list is neither necessary nor desired. Therefore, a standard distribution list for JTCG/AS publications does not exist. Each publication is distributed based on its content and requirements known to the sponsoring government engineer, his subgroup chairmen and the JTCG/AS Central Office in that order. Classified publications are distributed based on established need to know. Anyone desiring distribution of all documents in a particular subject area must contact one of the below with justification.

Susceptibility Reduction Subgroup	Philip Weinberg	(703) 325-0165
Vulnerability Reduction Subgroup	Joseph Jolley	(703) 325-0165
Survivability Methodology Subgroup	LCDR David Hattery, USN	(703) 325-0165
Group or Administrative	LCOL John Lawless, USA	(703) 325-0165

The JTCG/AS Central Office will maintain the Survivability Specialists Data Base which will be considered when individual report distribution lists are constructed.

JOINT TECHNICAL COORDINATING GROUP ON AIRCRAFT SURVIVABILITY (JTCG/AS)

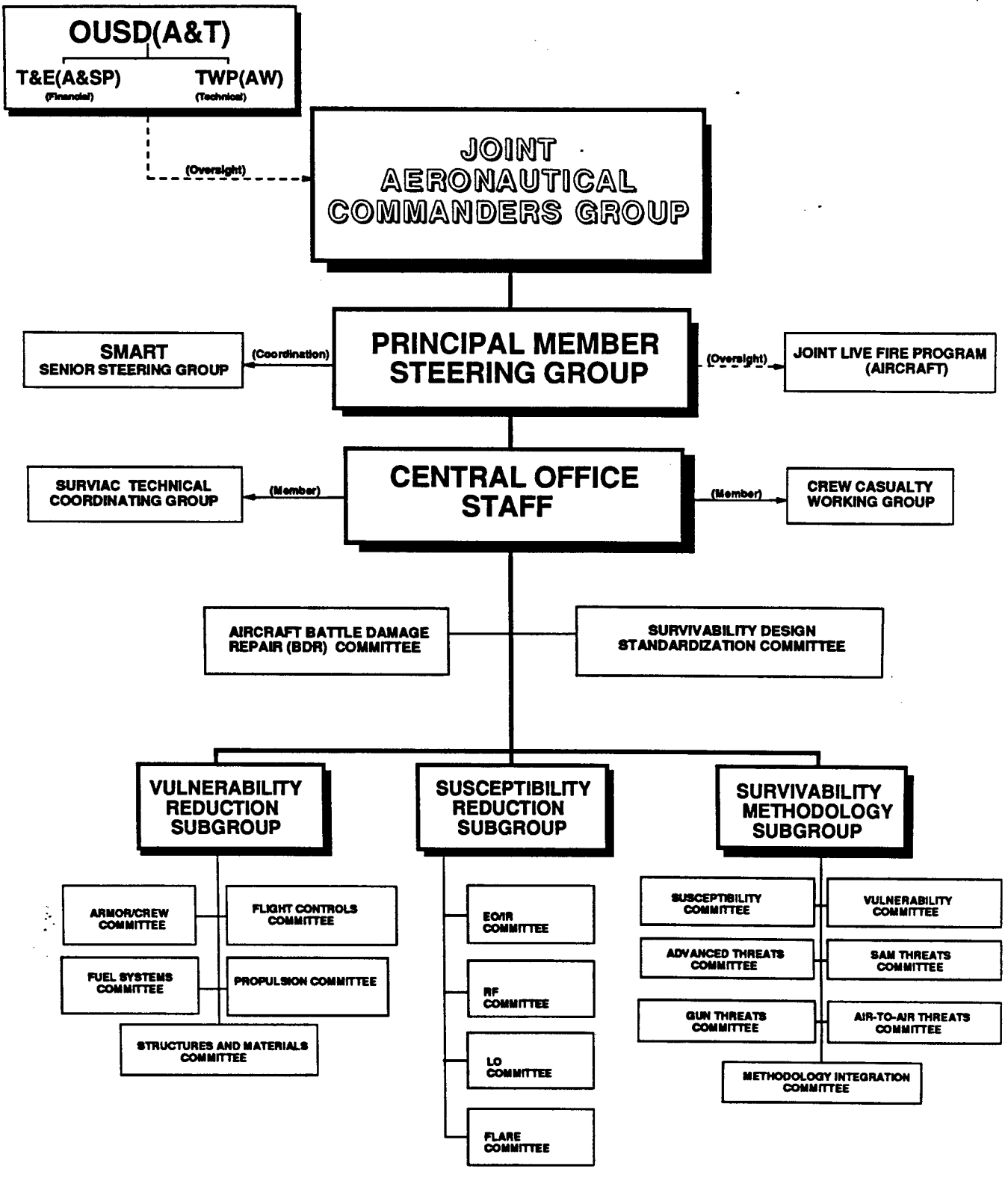

Figure 1. JTCG/AS Organization

Susceptibility Reduction Subgroup
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S-2-01 JTCG/AS-94-S-003 **SECRET/NOFORN/WNINTEL**

Title: Air-to-Air ARM Analysis and Modeling (U)

Issued: February 1994 **DTIC AD #:** Not Issued

Sponsor: Avionics Directorate Wright Laboratory **SURVIAC File #:** Not Issued
Air Force Materiel Command
WPAFB OH 45433-6543

Project Engineer: Eugene Sikora, WL/AAWW-1

Performing Organization: Georgia Tech Research Institute
Georgia Institute of Technology
Atlanta, GA 30332-0800

Author: Brian H. Mayhew, David G. Erickson

Abstract: (U) This study addressed the update of the TRAP/SPAM air-to-air ARM missile engagement simulation and the evaluation of selected countermeasure techniques with and without missile approach warning (MAW). The updates addressed changes to the missile seeker model and the replacement of TRAP version 3.0 with version 3.1A. The updated simulation provides the capability to evaluate electronic countermeasures against the current air-to-air ARM threat as defined by the National Air Intelligence Center (NAIC). A MAW model was included in the simulation to initiate selected countermeasures. The simulation was tested and selected countermeasures were evaluated. The results showed that for some engagements, the target aircraft is very vulnerable without warning. With warning, several techniques show the ability to significantly reduce lethality.

CM-9-01 JTCG/AS-94-S-001 **SECRET**
PYU 1187

Title: Countermeasure Munitions for Low and Slow Aircraft (U)

Issued: March 1994 **DTIC AD #:** Not Issued

Sponsor: ARDEC, U. S. Army Armament **SURVIAC File #:** Not Issued
SMCAR-AEE-O (R. Ritchie)
Picatinny Arsenal, NJ 07806-5000

Project Engineer: Rob Ritchie

Performing Organization: SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025

Author: Donald J. Eckstrom

Abstract: (U) Two tasks were accomplished.
Task 1 (IR) — This task investigated a wide range of infrared flare compositions with the objective of maximizing the two-color intensity ratio while simultaneously maximizing the absolute Band 4 intensity when tested in a 75 knot windstream. Although development efforts were centered on the use of energetic reactants to improve the performance of two-color flares, it was found that the detrimental effects of most additives, which usually were manifested as an increase in burn time, generally outweighed their benefits.

Task 2 (UV) — The approach to the development of UV countermeasure munitions was to identify compounds with strong ultraviolet absorption and to develop techniques for dispersing these materials into large clouds representative of the shape and UV contrast of low and slow aircraft. A substantial data base of candidate materials was developed, and characterized. Several candidate propellants were identified that might be useful for dispersing the absorbing material, including measurements of their exothermic heat release and gas generation rates. This level of accomplishment is very good for the first develoment effort of a completely new technology. We have established a strong base for continued development of UV countermeasure munitions.

CM-1-01 JTCG/AS-93-S-008 **SECRET**
NRL/MR-6552-92-7116

Title: Optical Overload in Focal Plane Arrays (U)

Issued: September 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Mel Kruer

Performing Organization: Naval Research Laboratory
Washington, DC 20375-5320

Author: M. R. Kruer, J. T. Caulfield, C. J. Gridley, and C. A. Hoffman

Abstract: (U) This paper presents the results of systematic measurements of degradation in IRFPAs due to optical overload. Results will be presented on three MWIR HgCdTe hybrid photovoltaic FPAs, two PtSi arrays, three CID InSb arrays, and one InSb hybrid photovoltaic FPA. Selected pixels of the FPAs were irradiated by single laser pulses having duration of 90 nanoseconds and also by continuous waveforms from a CW laser or an intense blackbody source.

(U) Physical mechanisms that lead to overload effects such as lag and crosstalk are discussed. The degradation that results from overload are analyzed from the standpoint of the various FPA components; the detector, input circuitry, and multiplexer. The results of the measurements are presented in terms that are believed important for sensor designers. for example, measured values are given for the flux levels which cause spurious responses in adjacent pixels. Other data is presented in terms of the amplitude of spurious signals as a function of the laser intensity in units of FPA saturation flux.

GP-2-02 JTCG/AS-93-S-007 **SECRET/NOFORN/WINTEL**
GTRI A-9070-000

Title: EW Development Opportunity Analysis (U)

Issued: August 1993 **DTIC AD #:** Not Issued
Sponsor: NVESD and JDL/TPEW **SURVIAC File #:** Not Issued

Project Engineer: Joe O'Connell

Performing Organization: Georgia Tech Research Institute
Georgia Institute of Technology
Atlanta, GA 30332-0800

Author: Multiple

Abstract: (U) The project reported (three volumes) has been directed towards supporting the development of the next generation of countermeasure technology. Specifically, it addresses the impact of Low Observable technology on future EW R&D. The product of this effort is a guide to EW R&D investment planning. It consists of the consolidation of a wide variety of EW and Observable issues into a format for the use of EW Tech Base managers during the next decade. As such, the specific threat and CM items considered are treated in broadly bounded regimes to ensure their relevance in the years ahead as both the threats and the countermeasure technologies evolve.

(U) The effort reported is an analysis of countermeasure techniques in the context of low observable signatures. It is not an analysis of low observables, per se. The signatures of specific platforms are not addressed and there is no discussion of specific signature reduction techniques nor resultant platform characteristics.

CM-2-02 JTCG/AS-93-S-006 **SECRET**

Title: Unique Multispectral Countermeasures Technology Tailored Flare (U)

Issued: October 1993 **DTIC AD #:** Not Issued

Sponsor: Wright Laboratory Avionics Directorate (WL/AAWW-3) **SURVIAC File #:** Not Issued
2241 Avionics Circle Suite 16
WPAFB, OH 45433-7318

Project Engineer: Joe Koesters

Performing Organization: ARC Professional Services Group
Information Systems Division

Author: William Pike (Lockheed Sanders), Chuck Files (Gen Sciences, Inc)

Abstract: (U) Experimental infrared (IR) decoys with tailored spatial and spectral intensity distributions were developed and tested under high speed simulated windstream conditions (0.5 and 0.8 mach) at NAVSURFWARCENDIV Crane. Two high temperature fuel chemistries were tested. IR signatures of the decoys at nose aspects were significantly reduced from the signatures at tail aspects. A method to specify the spatial and spectral intensity distributions of the decoy is developed and presented along with the decoy design and development data.

CM-2-02 JTCG/AS-93-S-005 **SECRET**
WL-TR-93-1118

Title: Aerovortical Tailorable Decoy (U)

Issued: August 1993 **DTIC AD #:** Not Issued

Sponsor: Wright Laboratory Avionics Directorate (WL/AAWW-3) **SURVIAC File #:** Not Issued
2241 Avionics Circle Suite 16
WPAFB, OH 45433-7318

Project Engineer: Joe Koesters

Performing Organization: Loral E-O Systems
300 N. Halstead Street P.O. Box 7101
Pasadena, CA 91109

Author: Stephen N. Schmotolocha, Robert J. Pederson

Abstract: (U) New, innovative, robust, active aerovortical tailorable decoy concepts were designed, developed, and demonstrated. Extensive testing showed that implementation of aerovortical technology resulted in decoy plume flowfield being highly three-dimensional and dominated by superturbulent intensity and coherent recirculatory structure. Vortex-induced turbulence amplification elevates turbulence kinetic energy, temperature and species levels far above their mean levels in regions of the decoy plume where their production rates would have otherwise greatly diminished. The highly turbovortical decoy plume aeroflow system allows the decoy to decouple chemikinetic from gasdynamic processes, and thus permit simultaneous improvements in power output and color ratio far beyond levels attained thus far with flares or other decoys. Using a standard flare grain composition a capability was demonstrated for augmenting MWIR power outputs, greatly improving spacial signature tailorability, and enhancing spectral emissions. The use of turbulator scale, opto-conical expanders and bypass air controllability affords further across-the-board performance improvements and/or tailorability.

CM-2-02 JTCG/AS-93-S-004 **UNCLASSIFIED**
WL-TR-93-1108

Title: Shielded Crucible Expendable

Issued: May 1993 **DTIC AD #:** Not Issued
Sponsor: Avionics Directorate **SURVIAC File #:** Not Issued
Wright Laboratory

Project Engineer: Joe Koesters

Performing Organization: Tracor/ San Ramon Operations
Bollinger Canyon Rd
San Ramon, CA 94583

Author: Omar Fawal, Carl Dinerman, Larry Weinman, Robert Kellett, and Jerry McDougal

Abstract: This report presents the details of research efforts to study the technical feasibility of a new decoy to protect Air Force tactical aircraft from infrared threats. Also, the test results are presented for a design concept which provides an infrared signature (IR spatial distribution) similar to that of an actual aircraft. The decoy heat source is a cylindrical "crucible" which is internally heated by a pyrotechnic mixture. The crucible radiant energy is subsequently redirected by a slotted shield "cone" to provide the desired spatial distribution.

CM-0-02 JTCG/AS-93-S-003 **SECRET**

Title: Reduced Bandwidth FLIR CCM (U)

Issued: June 1993 **DTIC AD #:** Not Issued
Sponsor: Naval Research Laboratory **SURVIAC File #:** Not Issued
Washington, D.C.

Project Engineer: Craig Hoffman

Performing Organization: Hughes Aircraft Company
Electro-Optical Systems
2000 E. El Segundo Rd
El Segundo, CA 90245-0902

Author: Craig Hoffman, NRL

Abstract: (U) This is the final technical report for the Reduced Bandwidth FLIR program. The primary program goal was to demonstrate a method of hardening Long Wavelength Infrared sensors against high and low intensity frequency-agile CO_2 laser threats by truncating the sensor passband, thereby excluding all CO_2 spectral lasing lines. This report covers the performance period from May 1992 through April 1993. During this period, Hughes produced direct-injection readouts for LWIR Focal Plane Arrays (FPAs); characterized the electrical and optical performance of the FPAs; and executed comparative performance tests and countermeasure susceptibility evaluations of several FLIR passband configurations.

CM-0-09 JTCG/AS-93-S-002 **SECRET**
WL-TR-93-1117

Title: On-Board Receiver and Countermeasure Laser (ORACL) (U)

Issued: September 1993 **DTIC AD #:** Not Issued
Sponsor: Avionics Directorate **SURVIAC File #:** Not Issued
Wright Laboratory
WPAFB, OH 45433-7409

Project Engineer: Rick Hunziker

Performing Organization: Laser Power Corporation
P.O. Box 2723
Del Mar, CA 92014

Author: G. Flint, D. Hargis, D. Breckinridge, K. Rodriguez, D. Tanimoto

Abstract: (U) In fulfillment of Contract F33615-90-C-1430, Laser Power Corporation has undertaken a program to develop and demonstrate a breadboard version of an On-board Receiver And Countermeasures Laser (ORACL) program. The program encompassed an ongoing review of potential laser weapon threats, the development of a breadboard system capable of countering those threats, together with extensive laboratory and field demonstrations concerning system effectiveness against a broad spectrum of anticipated threats. To develop a definition of laser countermeasure requirements for the near term, we have examined a wide range of weapon systems, both U.S. and foreign. These have been divided into two broad categories, namely those related to range finder/trackers and to semiactive laser missile systmes.

CM-8-01 JTCG/AS-93-S-001 **SECRET/NOFORN**

Title: Countermeasures Handbook for Aircraft Survivability (U)

Issued: August 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Michael K. Murray

Performing Organization: Wright Laboratory
2241 Avionics Circle
WPAFB, OH 45433-6543

Author: Members of the Susceptibility Reduction Subgroup, JTCG/AS: Michael K. Murray, Editor; Assoc. Editors: QuesTech, Inc., Dayton, OH; MacAulay-Brown, Inc., Dayton, OH. Individual Chapter authors are credited at the beginning of each Chapter.

Abstract: The purpose of this handbook is to provide a comprehensive, timely, and accurate publication on those aspects of EW that relate to aircraft survivability. For purposes of this handbook, EW includes radar and electro-optical warning, countermeasures equipment and techniques, expendable decoys such as chaff, flares, and electro-optical decoys, and electronic jammers and aircraft observable signature control techniques. The technical information is largely confined to EW, however there are some areas (i.e., medicine, space) that are included for completeness. This handbook is intended to be tutorial in nature for the use of Electonic Warfare planners, application designers, technicians, tacticians, and operators. The handbook is printed in three volumes. Volume I (Chapters 1 through 19) contains information on Introduction/Background/ Threat, Signature Technology, and Threat Detection/Avoidance. Volume II (Chapters 20 through 35) contains information on On-Board Self-Protection Countermeasures, Off-Board Self-Protection Countermeasures and Support Countermeasures. Volume III (Chapters 36 through 51) contains information of System Integration, Simulation/Test and Evaluation, and Tactics.

CM-2-01 WL-TR-92-1089 **SECRET NOFORN/WN**

Title: Air-to-Air ARM Countermeasures Program (U)

Issued: June 1992 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Eugene Sikora

Performing Organization: Avionics Directorate
WPAFB, OH 45433-7311

Author: Robert Dunning, Nick Mazzariello, George Turner, Joe Cikalo

Abstract: (U) The Air-to-Air ARM Countermeasures Program, Contract F33615-88-C-1736, had three objectives:

(U) 1. Analyze the vulnerability associated with a specific Air-to-Air ARM and develop candidate countermeasures to provide protection for U.S. aircraft.

(U) 2. Specify, design, and fabricate an Electronic Countermeasures (ECM) breadboard which can generate the required ECM techniques with variable parameters.

(U) 3. Evaluate the effectiveness of these techniques versus a missile seeker with comparable performance.

(U) This final Report summarizes details of the threat vulnerability assessment, hardware development, system performance, and effectiveness evaluation.

CM-1-01 JTCG/AS-92-SR-001 **SECRET**
NRL/MR-6552-92-7116

Title: Optical Overload in Focal Plane Arrays (U)

Issued: September 1992 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: M. R. Kruer

Performing Organization: Naval Research Laboratory
Washington, DC 20375-5320

Author: M. R. Kruer, J. T. Caulfield, C. J. Gridley, C. A. Hoffman

Abstract: (U) This paper presents the results of systematic measurements of degradation in IRFPAs due to optical overload. Results will be presented on three MWIR HgCdTe hybrid photovoltaic FPAs, two PtSi arrays, three CID InSb arrays, and one InSb hybrid photovoltaic FPA. Selected pixels of the FPAs were irradiated by single laser pulses having duration of 90 nanoseconds and also by continuous waveforms from a cw laser or an intense blackbody source.

(U) Physical mechanisms that lead to overload effects such as lag and crosstalk are discussed. The degradation that results from overload are analyzed from the standpoint of the various FPA components; the detector, input circuitry, and multiplexer. The results of the measurements are presented in terms that are believed important for sensor designers. For example, measured values are given for the flux levels which cause spurious responses in adjacent pixels. Other data is presented in terms of the amplitude of spurious signals as a function of the laser intensity in units of FPA saturation flux.

CM-0-01 JTCG/AS-91-SR-001 **UNCLASSIFIED**
WL-TR-91-1022

Title: EW Applications of Superconductivity

Issued: June 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 12270

Project Engineer: Paul A. Ryan, WL/ AAWW-1

Performing Organization: Wright Laboratory
Avionics Directorate
WPAFB, OH 45433-7318

Author: William F. H. Ring, Aly E. Fathy, Gerry B. Andeen, David M. Bubenick, Jeffery E. Casper, Jonathan B. Corey, Larry S. Gullman, M. Lattimer Wright

Abstract: This report investigates applications of superconductivity for enhanced aircraft survivability. Multi-service applications were of primary interest. Performance improvements over conventional approaches and logistic issues were emphasized.

CM-7-01 JTCG/AS-90-CM-002 **SECRET**
TR-90-1073

Title: LORALEI: The Advanced IR Decoy (U)

Issued: March 1990 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 11872

Project Engineer: Joe Koesters, WRDC/AAWW-3

Performing Organization: Loral EOS and Aerojet Solid Propulsion Lab

Author: S. N. Schmotolocha, R. Pederson, Ta-JIn Kuo, W. Donaldson and P. J. Trettel of Loral EOS and D. Woodman and T. J. Rieger of Aerojet Solid Propulsion

Abstract: (U) The objective of this program was to develop new off-board IR countermeasure technologies and an advanced decoy concept having kinematic and radiometric characteristics more closely resembling target aircraft. Furthermore, this program was to demonstrate the feasibility and practicality of this advanced decoy concept for protecting fixed and rotary wing aircraft and then to set bounds and limits for what can be ultimately achieved.

(U)Loralei is a miniaturized, aerodynamically maneuverable rocket-powered decoy that is spectrally matched to the target aircraft/helicopter, but with dominate intensity. It is not threat specific, but generic, and when coupled to a threat warning system, only one decoy per engagement is required.

(U)Loralei IR grains were tested at Mach 0.5 and 75 knots. Test results showed only a modest Band IV IR emission reduction at the Mach 0.5 conditions and minimal signature reduction at 75 knots flight speed. However, at higher airspeeds, Loralei's IR intensity increases, as demonstrated by additional tests conducted at NWSC/Crane (up to Mach 0.8) and Rockwell International wind tunnel (up to Mach 1/9 and 30,000 feet altitude). Thus, at supersonic speeds of about Mach 1.25, Loralei's power is fully restored to that at sea level static condition.
Based on test results, the Loralei decoy employing special molecular IRP solid fuel grain technology can effectively protect tactical fighters in all aspects, but the $\pm$ 20 degree tail cone against advanced IR threats. By integrating an intermetallic-reactive COMET technology into Loralei, full all-aspect protection can be achieved with spectral matching and can be packaged in current dispensers. Using a similar approach along with concept tailoring, both suppressed and unsuppressed helicopters can also be fully protected in all aspects. Based on recommended further improvements to the Loralei decoy, total emulation of fixed/rotary wing aircraft is possible.

CM-8-03 JTCG/AS-90-CM-001 **SECRET/NOFORN**

Title: Survivability and Hardening of Tactical Aircraft in a Laser Incurred Threat Environment (SHOTLITE) Follow-on Activity (U)

Issued: August 1990 **DTIC AD #:** C958015L

Sponsor: JTCG/AS **SURVIAC File #:** 01689

Project Engineer: Dr. Fred Stonesifer

Performing Organization: Naval Research Laboratory
Washington, D.C. 20375-5320

Author: B. Meyers, R. K. Munzer

Abstract: (U) This report covers the Survivability and Hardening of Tactical Aircraft in a Laser Incurred Threat Environment (SHOTLITE) Follow-on Activity. The performance period was April 1989 to June 1990. The data in this report focuses on the changes between this study and the original SHOTLITE study which was performed between September 1984 and May 1986. The original SHOTLITE program, Contract Number N00014-84-C-2353, was fully documented in JTCG/AS Report Number JTCG/AS-86-CM-002.

CM-7-01 JTCG/AS-89-T-008 **SECRET**
TR-89-1144

Title: Alternate IR Decoy Flare (U)

Issued: November 1989 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 11871

Project Engineer: Joe Koesters, WRDC/AAWW-3

Performing Organization: Wright Laboratories
WPAFB, OH 45433-7318

Author: C. E. Dinerman, D. G. Matuska, A. V. Fields - Tracor Aerospace, Expendables Technology Center

Abstract: (U) The objective of this alternate IR Decoy program was to improve the long IR wavelength volumetric efficiency of shrouded flare configurations. To obtain the desired efficiency improvement, conventional pyrotechnic compositions were modified by the addition of various elements/compounds. In addition, various shroud lining materials were used for the purpose of adding combustion products, and insulating against heat loss.

(U) Pyrotechnic compositions and lining materials were selected from the results of a previous WRDC contract, Controlled Output Flare (F33615-84-C-1419). Phase I of this Alternate IR Decoy program involved the data review of previous efforts, and fabrication/testing of subscale flare hardware. Based upon the results of Phase I, Phase II involved further tests of full-scale flares using the Advanced Aerodynamic Flare as the baseline test configuration. Phase II testing was conducted by the Naval Weapons Support Center, Crane, IN using their windstream test facility.

(U) Phase II test data was not available at publication, however, will be made available as a separate Crane NSWC document at a later date.

CM-7-01 JTCG/AS-89-T-007 **CONFIDENTIAL**
TR-89-1127

Title: Alternate IR Decoy Development (U)

Issued: February 1990 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 11870

Project Engineer: Joe Koesters, WRDC/AAWW-3

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: D. J. Eckstrom, R. J. Schmitt, R. T. Rewick, B. Kingsley, G. R. Greenfield, T. J. Henry of SRI International

Abstract: (U) The objective of this program is to improve the performance of infrared (IR) decoy flare by improving their spectral match to the aircraft while increasing absolute intensity in the long IR wavelength. This was done through the identification of new flare composition materials and a new flare configuration. These compositions and configurations were tested in a free-flight test facility based on an airgun launcher to show compliance with program goals. Based on test results, flare compositions were identified which offer the potential of achieving the objective stated above.

CM-7-01 JTCG/AS-89-CM-001 **SECRET**
WRDC-TR-89-1126

Title: Alternate IR Decoy (U)

Issued: September 1989 **DTIC AD #:** B137327
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Paul Egbert

Performing Organization: Avionics Laboratory
WPAFB, OH 45433

Author: Egbert, Paul, Kuppenheimer, J. D.

Abstract: (U) Program goals included development of a visually covert flare, a spatial pattern to protect typical aircraft signatures, tailoring of flare spectral signature to defeat missile spectral discriminents, and tailoring of flare rise time to defeat missile temporal discriminents.

CM-5-03 JTCG/AS-88-CM-001 **SECRET**
AFWAL-TR-88-1086

Title: Pyrotechnic Expendable Laser Jammer Configuration (U)

Issued: October 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** C044512L

Project Engineer: Richard D. Hunziker, AFWAL/AAWW-3

Performing Organization: Sanders Associates
95 Canal Street
Nashua, NH

Author: Cathy Reed, James Beattie, Patrick Perkins, and Evan Chicklis of Sanders Associates, Inc.

Abstract: (U) Detailed abstract is classified. This final report describes the 31-month effort on USAF Contract F33615-85-C-1701 entitled "Pyrotechnic Expendable Laser Jammer Configuration." The work was performed by Sanders Associates, a Lockheed Corporation, 95 Canal Street, Nashua, NH. This effort was jointly funded by AFWAL Project 2000 and JTCG/AS.

CM-4-06 JTCG/AS-86-CM-002 **SECRET/NOFORN**

Title: Survivability & Hardening of Tactical Aircraft in a Laser Incurred Threat Environment (SHOTLITE) (U)

Issued: March 1987 **DTIC AD #:** Not Issued

Sponsor: Naval Research Laboratory, Washington, D.C. **SURVIAC File #:** 01479L

Project Engineer: Dr. George Mueller

Performing Organization: Verac, Inc.

Author: Dr. George Mueller, NRL

Abstract: (U) The SHOTLITE study, performed under the sponsorship of the JTCG/AS, examined the ground based battlefield laser threat in a tri-service aircraft mission environment. Tri-service (Air Force, Army, and Navy/Marine Corps) aircraft, systems, and missions were considered in the development of the impacts of a laser threat on aircraft survivability. Survivability analysis was used to provide a criticality ranking of various vulnerable aircraft components. Requirements for, and benefits and penalties of, hardening the critical aircraft components were analyzed and have been discussed in the Final Report. The SHOTLITE analysis, as presented in the program Final Report, provides a needed baseline of tri-service aircraft vulnerability to the potential battlefield laser threat, and also yields valuable insight into the nature of aircraft laser vulnerability and the most desirable hardening responses.

CM-4-01 JTCG/AS-86-CM-001 **SECRET**
AFWAL TR-85-1168

Title: Electro Optical/Radio Frequency Decoy (U)

Issued: April 1986 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 07092

Project Engineer: D. Moore

Performing Organization: Avionics Directorate, WPAFB, OH

Author: K. Jacobson, H. Herm, D. Moore, et. al.

Abstract: (U) A study was performed to integrate Electro-Optical and radar frequency signature augmentation devices on a penetration aid decoy platform. Previous efforts were reviewed and compared with current tactical mission doctrine. Updated decoy requirements were then developed and traded-off in a utility analysis of cost and effectiveness measures. Preliminary designs were produced for two configurations with other variations, of mission specific design, evaluated for comparison. It was determined that a modular payload was suited for these designs, allowing a broader application of the decoy concept. This program sets the basis for advanced development of the integrated EO/RF decoy which can effectively counter the integrated threat.

CM-1-06 JTCG/AS-85-CM-004 **SECRET (Vol VI) UNCL (Vol I-V)**
AFWAL-TR-85-1180

Title: Optical Zinger (OZ) Model Documentation (U) (AFWAL-TR-85-1180)

Issued: February 1986 **DTIC AD #:** B106309L
Sponsor: JTCG/AS **SURVIAC File #:** 6806/7/8/9/1 0&8142
Project Engineer: Dr. George Mueller, NRL
Performing Organization: Naval Research Laboratory
4555 Overlook Ave., SW
Washington, D.C. 20375-5320
Author: Quest Research Corp.

Abstract: (U) Optical Zinger (OZ) is a combined detection, engagement, and cost assessment model developed to investigate the effectiveness of optical and electro-optical countermeasures (OCM/EOCM) in enhancing aircraft survivability. This manual is oriented toward the engineering/mathematical modeler.

CM-1-06 JTCG/AS-85-CM-003 **UNCLASSIFIED**
AFWAL-TR-851179

Title: EOCM Effectiveness Measures Simulation Development

Issued: February 1986 **DTIC AD #:** B105343L
Sponsor: JTCG/AS **SURVIAC File #:** 6799
Project Engineer: Dr. George Mueller, NRL
Performing Organization: Naval Research Laboratory
4555 Overlook Ave., SW
Washington, D.C. 20375-5320
Author: Quest Research Corp.

Abstract: Optical Zinger (OZ) is a combined detection, engagement, and cost assessment model developed to investigate the effectiveness of optical and electro-optical countermeasures (OCM/EOCM) in enhancing aircraft survivability. This report discusses the historical development of the model, the current status of the model, and some of the most important applications.

JTCG/AS-85-CM-002 **SECRET**

Title: Fire Control System Survivability Analysis Technical Note - Biological Effects Caused by High-Power Microwave Weapons (U)

Issued: January 1985 **DTIC AD #:** C038574
Sponsor: JTCG/AS **SURVIAC File #:** 01769L
Project Engineer: Dr. George Mueller, NRL
Performing Organization: Naval Research Laboratory
4555 Overlook Ave., SW
Washington, D.C. 20375-5320
Author: Quest Research, Inc.

Abstract: (U) This document summarizes the microwave threat and exposure levels that could be experienced by a pilot during standard DoD scenarios. It summarizes human biological effects resulting from varying microwave exposure levels as found in literature during the period from 1956 to 1982. Finally, critical effects and exposure levels are evaluated and summarized.

CM-4-04 JTCG/AS-85-CM-001 **SECRET/NOFORN/WNINTEL**

Title: Fire Control Systems Survivability Analysis (U)

Issued: September 1985 **DTIC AD #:** C038575

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Dr. George Mueller

Performing Organization: Naval Research Laboratory
4555 Overlook Ave., SW
Washington, D.C. 20375-5320

Author: George Mueller, NRL/Quest Research

Abstract: (U) For the Vulnerability to Directed Energy Weapons (VUDEW) Committee of the JTCG/AS, Quest Research Corporation identified and quantified the vulnerability of selected weapons systems, and fire control and other mission-critical systems to projected/postulated threat High-Power Microwave (HPM) Directed Energy Weapons (DEWs). The impact of the use of current hardening techniques was included in the scope of the study. The study examined the vulnerability of the F-16 and F-18 aircraft and the AAH-64 Advanced Helicopter. Scenarios depicting the unique combat environment for each of the systems were used to support the analysis. A final report summarized the results of the investigation and provided recommendations for further analysis and additional testing. NRL point of contact is Dr. George Mueller.

CM-2-08 JTCG/AS-83-CM-002 **SECRET**
USA AVSCOM TR 85-D-16

Title: Helicopter Canopy Multi-ply Laser Countermeasures (U)

Issued: May 1986 **DTIC AD #:** C039405L

Sponsor: JTCG/AS **SURVIAC File #:** 01299

Project Engineer: Penunuri, Barbara

Performing Organization: U.S. Army Aviation Technology Directorate
Safety & Survivability Dir. Bldg 401
Ft. Eustis, VA 23604-5577

Author: Penunuri, Barbara

Abstract: (U) The objective of this program was to develop and validate a transparent enclosure that would protect the aircrew of an AH-1S helicopter from high- and low-energy laser emission, from flashblindness induced by a nuclear blast or laser-induced reradiation, and to provide this protection with a sufficient structural integrity to withstand the overpressure from a nuclear blast.

CM-0-05 JTCG/AS-83-CM-001 **SECRET**
TA-1-02

Title: Fire Control System Survivability Analysis (U)

Issued: December 1983 **DTIC AD #:** C034447L

Sponsor: JTCG/AS **SURVIAC File #:** 03777

Project Engineer: Dr. George Mueller

Performing Organization: Naval Research Laboratory
4555 Overlook Ave., SW
Washington, D.C. 20375-5320

Author: Gene Kempe, Quest Research

Abstract: (U) This document is an interim technical report that summarizes and discusses results to date of an ongoing investigation to identify and quantify potential vulnerabilities of U. S. aircraft fire control systems and other mission-critical avionics systems to high-power microwave directed energy weapons (DEWS) that might be deployed in the near future.

CM-2-03 JTCG/AS-82-C-001 TR-83-D-10 — UNCLASSIFIED

Title: Helicopter Mounted Turret Smoke Launcher Test

Issued: March 1983 — **DTIC AD #:** B073106L

Sponsor: JTCG/AS — **SURVIAC File #:** 03552

Project Engineer: L. Dikant

Performing Organization: U.S. Army Aviation Technology Directorate
Safety & Survivability Dir. Bldg 401
Ft. Eustis, VA 23604-5577

Author: L. Dikant

Abstract: An experimental smoke/aerosol countermeasure system for helicopters has been designed, fabricated, and flight tested on an AH-1S helicopter. The system consists of a six-round turret launcher developed jointly by the Applied Technology Laboratory and Boeing Aerospace Company and specially designed red phosphorous smoke grenades developed by the US Army Chemical Systems Laboratory. During flight tests conducted at the Aviation Development Activity (Ft. Rucker, AL), 84 smoke rounds were fired from a hovering AH-1S. The turret launcher and smoke rounds generally performed according to design specifications. A two-round burst produced effective visual masking of the aircraft.

CM-2-08 JTCG/AS-81-C-003 TR 83-D-16 — SECRET

Title: Helicopter Canopy Removable Sheet Laser Countermeasures (U)

Issued: January 1984 — **DTIC AD #:** C033711L

Sponsor: JTCG/AS — **SURVIAC File #:** 01172

Project Engineer: Uram, John Jr.

Performing Organization: U.S. Army Aviation Technology Directorate
Safety & Survivability Dir. Bldg 401
Ft. Eustis, VA 23604-5577

Author: Uram, John Jr.; Penunuri, Barbara; Schlottig, John

Abstract: (U) This program developed transparent, removable enclosures for an AH-1S helicopter to protect crew members against hazardous high- and low-energy laser radiation. Two approaches were taken to provide the required protection – a flexible, transparent shield and a rigid contoured transparency. Both approaches were characterized, and experimental AH-1S gunner's door transparencies fabricated.

CM-6-05 JTCG/AS-81-C-002 — UNCLASSIFIED

Title: Aircraft Infrared Measurements Guide

Issued: March 1983 — **DTIC AD #:** A132598

Sponsor: JTCG/AS — **SURVIAC File #:** 03556

Project Engineer: W. L. Capps

Performing Organization: Joint Infrared Standards Working Group

Author: W. L. Capps, D. Powlette, S. E. Tate, et al

Abstract: A reference source for the aircraft infrared measurement community is proposed. The guide provides standard nomenclature, suggested data formats, calibration requirements (including derived mathematics), and measurement methodology. Chapters are also included on developing test plans and writing the formal report. An extensive bibliography contains sections on calculations aids/equation, calibration, radiometry/spectrometry, and radiation sources.

JTCG/AS-81-C-001 **SECRET (Vol I & III)**
AFWAL TR-82-3041

Title: RCS Design Guidelines: Aircraft Configuration Selection for RCS Control, Volume I - Final Report, Volume II - Test Report (U)

Issued: August 1982 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 03900

Project Engineer:

Performing Organization: Wright-Patterson AFB, OH

Author: T. G. Dalby, F. W. Fischer, and W. P. Hansen

Abstract: (U) This study investigated the effects of configurational changes on RCS and, to a limited extent, on performance of typical baseline air vehicles. An extensive study of existing TCS literature was made and a bibliography covering approximately 1,000 documents was developed (Volume 2). Through use of small models and a millimeter wavelength RCS range, experimental analyses were carried out to assess RCS configurations of these vehicles (Volume 3). Variations in performance of these alternate configurations were also assessed. Effects on RCS variations in general aircraft elements were also investigated; in particular, general configuration, inlets/nozzles, fins/control surfaces, antennas and radomes, canopy, and external stores were considered.

CM-8-01 **JTCG/AS-80-C-004** **UNCL (Vol I), SECRET (Vol II)**
TR-81-1105

Title: Optical Zinger Model - Users Manual (Vol I); Analyst Manual (Vol II) (U)

Issued: August 1981 **DTIC AD #:** C951637
Sponsor: JTCG/AS **SURVIAC File #:** 11698

Project Engineer: E. Leaphart, WPAFB

Performing Organization: Wright-Patterson AFB, OH

Author: E. Leaphart, WPAFB

Abstract: (U) This report presents the results, assumptions and rationale of the development of a combination engagement and cost assessment model, designated Optical Zinger (OZ), which incorporates optical countermeasures (OCM) into the TAC ZINGER SAM engagement models, GREATSAM and NEWSAM and P001, the generic family of AAA engagement models.

CM-8-01 **JTCG/AS-80-C-003** **SECRET**
TR-81-1105

Title: Optical Countermeasures Effectiveness Measures Simulation - Vol II (U)

Issued: August 1981 **DTIC AD #:** B082156
Sponsor: JTCG/AS **SURVIAC File #:** 3315

Project Engineer: E. Leaphart

Performing Organization: Wright-Patterson AFB, OH

Author: A. Luebcke, G. Stoops, and S. Herr, Quest Research Corporation

Abstract: (U) This report summarizes a digital model development effort to develop a simulation to assess the effects of Optical Countermeasures (OCM) in enhancing aircraft survivability. Volume II implements the OCM Modeling Methodology discussed in Volume I (Report JTCG/AS-79-C-002, and AFWAL-TR-78-187, publication SECRET), which defined modeling techniques and procedures for evaluating measures of OCM effectiveness.

JTCG/AS-80-C-002 **UNCLASSIFIED**

Title: Uncertainty Analysis of Optical Measurement Equipment

Issued: November 1980 **DTIC AD #:** B053931

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer:

Performing Organization: Naval Weapons Center
China Lake, CA

Author: J. Mudar, Environmental Research Institute Of Michigan

Abstract: A general methodology of conducting an uncertainty analysis on optical measurement equipment starting with a defining measurement equation is discussed. The general methodology is then applied to an infrared imaging radiometer and two infrared spectroradiometric systems. The imaging system is the Beam Approach Seeker Evaluation System (BASES) at Eglin AFB, FL. One of the spectro-radiometers is the Infrared Spectral Measurement System (ISMS) at the Army White Sands Missile Range, the other is the SPEC LAB spectro-radiometer at the Naval Weapons Center, China Lake, CA.

CM-6-03 **JTCG/AS-80-C-001** **UNCLASSIFIED**
TR-78-25

Title: Infrared Emissions Analysis Utility Matrix for Inflight Aircraft - Volume I, User Manual

Issued: August 1980 **DTIC AD #:** B053076L

Sponsor: JTCG/AS **SURVIAC File #:** 05491/2

Project Engineer: S. E. Tate

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: C. W. Stone, R. B. Edleman, P. T. Harsha, and F. G. Smith, Science Applications, Inc.

Abstract: A means of determining which of the available IR signature model(s) should or could be used to generate the IR signature of any specified airbreathing airborne weapon system is developed. The identification algorithm presented is in the form of an "Applicability Algorithm" which has the capability to generate the analysis requirements for any generic airbreathing weapon system found in military (or civilian) service. This Applicability Algorithm serves two major functions. First, it displays the ability (or suitability) of selected computer models to analyze the IR signatures of generic airbreathing weapons systems. Second, it provides a description of the computational capabilities required to reliably model a given weapon system's IR signature. All IR signature model data used in the Applicability Algorithm were obtained from the developers of the included programs via mailed survey questionnaires.

CM-6-03 JTCG/AS-80-C-001 **UNCLASSIFIED**
TR-78-25

Title: Infrared Emissions Analysis Utility Matrix for Inflight Aircraft - Volume II, Analyst Manual

Issued: June 1980 **DTIC AD #:** B052076
Sponsor: JTCG/AS **SURVIAC File #:** 5492

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
Wright-Patterson AFB, OH 45433

Author: C. W. Stone, R. B. Edleman, P. T. Harsha, and F. G. Smith, Science Applications, Inc.

Abstract: A means of determining which of the available IR signature model(s) should or could be used to generate the IR signature of any specified airbreathing airborne weapon system is developed. The identification algorithm presented is in the form of an "applicability algorithm" which has the capability to generate the analysis requirements for any generic airbreathing weapon system found in military (or civilian) service. This Applicability Algorithm serves two major functions. First, it displays the ability (or suitability) of selected computer models to analyze the IR signatures of generic airbreathing weapons systems. Second, it provides a description of the computational capabilities required to reliably model a given weapon system's IR signature. All IR signature model data used in the applicability Algorithm were obtained from the developers of the included programs via mailed survey questionnaires.

CM-6-04 JTCG/AS-79-C-004 **CONFIDENTIAL**
TR-78-54

Title: Aerosol Laser Passive Countermeasures Conceptual Development (U)

Issued: May 1979 **DTIC AD #:** C018650L
Sponsor: JTCG/AS **SURVIAC File #:** 11873

Project Engineer: J. Ladd, AMRDL

Performing Organization: U.S. Army Research Test Laboratory
Ft. Eustis, VA

Author: G. M. Hess, Boeing Aerospace Co.

Abstract: (U) The purpose of this program was to investigate conceptual development and evaluate Aerosol/Smoke Systems compatible with the A-1 type helicopter that would provide a countermeasure for any weapon system that depends on visual acquisition, laser designation and laser range finding for delivery of effective fire on the helicopter. The results of established theoretical easability of a smoked countermeasure system to enhance survivability on the attacked helicopter in its anti-armor roll.

CM-6-05 JTCG/AS-79-C-003 **UNCLASSIFIED**

Title: Infrared Measurement Variability Analysis

Issued: September 1980 **DTIC AD #:** A092068

Sponsor: JTCG/AS **SURVIAC File #:** 2889

Project Engineer: W. L. Capps

Performing Organization: Naval Research Laboratory
Washington, D.C.

Author: N. K. Matthis, T. J. Morin, and W. E. Thompson, ARINC Research Corp., Wash., D.C.

Abstract: Two different Michelson interferometer measurement systems were used to collect spectral radiant intensity data describing blackbody emissions. These data were subjected to statistical and numerical analysis for the purpose of characterizing infrared measurement variability. A mathematical model has been postulated to describe the variability of infrared measurements based on the results of this analysis. Recommendations are made for future study to verify and extend the results presented in this report.

CM-8-01 JTCG/AS-79-C-002 **SECRET**

Title: Optical Countermeasures Effectiveness Measures Simulation - Vol I (U)

Issued: December 1978 **DTIC AD #:** B031976L

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: E. Leaphart, WPAFB

Performing Organization: Wright-Patterson AFB, OH

Author: G. Hetley, M. Tollin, and A. Luebcke, Quest Research Corp.

Abstract: (U) This report presents the results of a study to develop a methodology for modeling the effectiveness of optical countermeasures in enhancing aircraft survivability against optically controlled weapons. The purpose of the report is to provide modeling techniques for evaluating measures of OCM effectiveness in the initial form of computer flow charts and guidelines.

JTCG/AS-76-CM-001 **Vol I & II - SECRET, Vol III-UNCLASSIFIED**

Title: Countermeasures Handbook for Aircraft Survivability (U)

Issued: February 1977 **DTIC AD #:** C021636

Sponsor: JTCG/AS **SURVIAC File #:** 2075/2076

Project Engineer: Philip Sandler, AFSC

Performing Organization: Air Force Systems Command
Washington, D.C.

Author: Philip Sandler, AFSC, AAFB and Marcellus R. McLaughlin and Parlan L. McGivern, Telcom Systems, Inc.

Abstract: (U)This handbook provides a comprehensive, timely, and accurate publication on those aspects of electronic warfare that relate to aircraft survivability. It is intended to be tutorial in nature for the use of electronic warfare staff personnel, technicians, tacticians, operators, and for some applications electronic warfare designers. It should also be remembered that this is a compilation by individual contributors and as such, portions of some chapters may tend to reflect differing viewpoints. This handbook reflects current (as of 1976) electronic warfare technological advances and state-of-the-art that have transpired since publication of the U.S/ Army sponsored Electronic countermeasures book in 1961.

(U) An update to this Handbook has been published (JTCG/AS-93-S-001).

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VP-2-01 JTCG/AS-94-V-002 **UNCLASSIFIED**
NAWCWPNS TP 8203

Title: Steady-Flow Fuel Ingestion Tolerance Predictions for New Turbofan Engines

Issued: October 1994 (Est) **DTIC AD #:** Not Issued
Sponsor: NAWCWPNS **SURVIAC File #:** Not Issued
Survivability and Lethality Division
China Lake, CA

Project Engineer: Charles Frankenburger, Code C2183

Performing Organization: ASI Systems International
825 N. Downs Street
Ridgecrest, CA 93555

Author: Gary Burgner

Abstract: This monograph is published under the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) Project VP-2-01, "Fuel Ingestion Tolerance Specification." This project has as its objective the development of specifications and related test techniques by which engines can be qualified to demonstrate adequate tolerance of inlet fuel ingestion. It will also develop technology to rapidly detect imminent fuel ingestion and mitigate its effects, and disseminate this technology to the engine industry.

This report was reviewed for technical accuracy by Lester W. Throndson and John W. Holtrop. Work continues in the fuel ingestion field, and the contents of this report are subject to revision.

VP-2-01 JTCG/AS-94-V-001 **UNCLASSIFIED**
NAWCWPNS TP8201

Title: Engine Assessment of Methods to Detect Inlet Fuel Ingestion and Mitigate Its Effects

Issued: August 1994 **DTIC AD #:** Not Issued
Sponsor: NAWCWPNS **SURVIAC File #:** Not Issued
Survivability and Lethality Division
China Lake, CA

Project Engineer: Les Throndson

Performing Organization: ASI Systems International
825 N. Downs Street
Ridgecrest, CA 93555

Author: Gary Burgner

Abstract: (U) The failure of jet engines as a result of fuel ingestion accounts for a substantial fraction of all combat aircraft losses. This report describes engine tests of concepts and hardware developed to detect imminent engine fuel ingestion and mitigate its effects. The successful approaches identified in these tests, in addition to reducing the aircraft's fuel ingestion vulnerability, have helped define approaches and test procedures that would be used to verify compliance with fuel ingestion tolerance specification for new engines.

VC-7-02 JTCG/AS-93-V-001 **UNCLASSIFIED**
NAWCAD-93061-60

Title: Advanced Hydraufluidic Technology Demonstration Applied to F/A-18 Hornet Aircraft

Issued: December 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS and N-88W **SURVIAC File #:** Not Issued

Project Engineer: David Keyser

Performing Organization: NAWCAD-Warminster, HR Textron, Inc. and McDonnell Douglas Aerospace

Author: David Keyser, Richard C. Deitrich

Abstract: This report validates that hydraufluidic technology can control the flight of an advanced tactical aircraft for adequate range of backup flight profiles. Flying qualities analysis and piloted simulation have demonstrated that an F/A-18 Hornet aircraft configured with a hydraufluidic backup flight control system can achieve adequate flying qualities for carrier approach and landing, and aerial refueling. The system is a hydraulic oil-based fluidic system with temperature-compensated laminar angular rate sensors (providing stability augmentation), digital fly-by-wire or fluidic control of hydraulic actuators, and fluidic gain-changing between cruise and approach. A two-axis system, developed for flight demonstration, and a three-axis production-type system for an advanced tactical aircraft are presented. This report contains discussions of concept and hardware development, flying qualities analysis, piloted simulation and assessment, aircraft integration concepts and designs, and component and system test results. This technology can provide "get home" capability for tactical aircraft where digital flight control has failed or been disrupted. Also, fluidics can provide primary or backup flight control functions for trainer, helicopter, or transport aircraft where reliability, low maintenance requirements, and operation in a harsh environment are paramount.

VS-9-02 JTCG/AS-92-VR-012 **Unclassified**

Title: History of Ballistic Testing on Large Scale All-Composite Aircraft Structure

Issued: July 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Todd Anderson

Performing Organization: Naval Air Warfare Center Weapons Division
China Lake, CA 93555-6001

Author: Todd Anderson

Abstract: This report identifies the ballistic testing of large scale all-composite aircraft structures that took place through 1990. Previously published test documentation is briefly reviewed, while unpublished analyses are dealt with more substantially. One important direction of the Joint Technical Coordinating Group for Aircraft Survivability (JTCG/AS) structures committee has been the development of computer code for predicting ballistic damage to composite structures, particularly hydraulic ram induced damage. This report will allow for a quick review of the types of data available for use in validating damage prediction codes.

VC-1-01 JTCG/AS-92-VR-011 **Unclassified**
WL-TR-93-3033

Title: High Power Microwave Testing of a Digital Flight Control Computer

Issued: August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Bruce Clough and Wm Baron, WL/FIBC

Performing Organization: Wright Laboratory
WPAFB, OH 45433

Author: Jurt J. Ianacone, David Baughman, Gary Brock

Abstract: This report gives results of testing a digital flight control computer in a high power microwave environment. Upset levels and types were recorded while the equipment was exposed to microwave pulses of varying width, intensity, and repetition rate. Results show that this computer configuration is hard to high power microwaves. Upsets were seen only above 10 W/cm^2. Simple shielding techniques can provide up to 10 db of protection at the frequencies tested. Upsets were chaotic, with the type of upset recorded as a function of the incident power level. This report describes the results of testing a digital flight control computer for microwave coupling. Coupling levels and equivalent antenna aperature area are given.

This is one of four reports covering the testing of a digital flight control computer for microwave vulnerability. They are: Low Level Coupling Assessments of a Digital Flight Control Computer (JTCG/AS-92-VR-008), Direct Microwave Injection of a Digital Flight Control Computer (JTCG/AS-92-VR-009), Pulse Injection of the Cross Channel Data Links of a Digital Flight Control Computer (JTCG/AS-92-VR-010), and High Power Microwave Testing of a Digital Flight Control Computer (JTCG/AS-92-VR-011).

VC-1-01 JTCG/AS-92-VR-010 **Unclassified**
WL-TR-93-3036

Title: Pulse Injection of the Cross Channel Data Links of a Digital Flight Control Computer

Issued: August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Bruce Clough and Wm Baron, WL/FIBC

Performing Organization: Wright Laboratory
WPAFB, OH 45433

Author: Jurt J. Ianacone, David Baughman, Gary Brock

Abstract: Digital flight control computer cross channel data links were subject to pulses replicating demodulated high power microwave signals. The computer system failures, along with conclusions and recommendations, are included.

This is one of four reports covering the testing of a digital flight control computer for microwave vulnerability. They are: Low Level Coupling Assessments of a Digital Flight Control Computer (JTCG/AS-92-VR-008), Direct Microwave Injection of a Digital Flight Control Computer (JTCG/AS-92-VR-009), Pulse Injection of the Cross Channel Data Links of a Digital Flight Control Computer (JTCG/AS-92-VR-010), and High Power Microwave Testing of a Digital Flight Control Computer (JTCG/AS-92-VR-011).

VC-1-01 JTCG/AS-92-VR-009 **Unclassified**
WL-TR-93-3034

Title: Direct Microwave Injection of a Digital Flight Control Computer

Issued: August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Bruce Clough and Wm Baron, WL/FIBC

Performing Organization: Wright Laboratory
WPAFB, OH 45433

Author: Proj Engineer is Bruce Clough and Wm Baron, WL/FIBC

Abstract: Microwave energy was directly injected into various digital flight control computer circuits to determine upset levels. These levels were established and upsets sorted according to type. The data within was combined with low power coupling test data to predict high power microwave upset levels.

This is one of four reports covering the testing of a digital flight control computer for microwave vulnerability. They are: Low Level Coupling Assessments of a Digital Flight Control Computer (JTCG/AS-92-VR-008), Direct Microwave Injection of a Digital Flight Control Computer (JTCG/AS-92-VR-009), Pulse Injection of the Cross Channel Data Links of a Digital Flight Control Computer (JTCG/AS-92-VR-010), and High Power Microwave Testing of a Digital Flight Control Computer (JTCG/AS-92-VR-011).

VC-1-01 JTCG/AS-92-VR-008 **Unclassified**
WL-TR-93-3033

Title: Low Level Microwave Coupling Assessments of a Digital Flight Control Computer

Issued: August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Bruce Clough and Wm Baron, WL/FIBC

Performing Organization: Wright Laboratory
WPAFB, OH 45433

Author: Jurt J. Ianacone, David Baughman, Gary Brock

Abstract: This report describes the results of testing a digital flight control computer for microwave coupling. Coupling levels and equivalent antenna aperature area are given.

This is one of four reports covering the testing of a digital flight control computer for microwave vulnerability. They are: Low Level Coupling Assessments of a Digital Flight Control Computer (JTCG/AS-92-VR-008), Direct Microwave Injection of a Digital Flight Control Computer (JTCG/AS-92-VR-009), Pulse Injection of the Cross Channel Data Links of a Digital Flight Control Computer (JTCG/AS-92-VR-010), and High Power Microwave Testing of a Digital Flight Control Computer (JTCG/AS-92-VR-011).

VC-1-01 JTCG/AS-92-VR-007 **Unclassified Limited Distribution**
WL-TM-93-304

Title: Testing Environment for Establishing Vulnerability of Digital FCS to High Power Microwave Radiation

Issued: May 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Bruce Clough and Wm Baron, WL/FIBC

Performing Organization: Wright Laboratory
WPAFB, OH 45433

Author: Bruce Clough and Wm Baron, WL/FIBC

Abstract: This Technical Memorandum presents a specific set of test recommendations for determining digital flight control system (DFCS) vulnerability to high power microwave (HPM) radiation. The test techniques and levels were determined through actual testing of a DFCS in an HPM environment, as well as other avionics systems similar in electronic construction. Current DFCS are complicated systems with significant automated capability. Any testing technique has to take into account system characteristics such as the built in tests and redundancy management software mechanized in these fault tolerant, flight critical systems. Examination of hardware alone will lead to erroneous predictions on system vulnerability. Prior HPM tests have been hampered by the lack of understanding system operation. Testing has to catch both digital upsets and analog upsets, a combination which could lead to several test specific software versions. The goal is to augment production tests to cover HPM signal characteristics, upsets, and point toward cures. The rational build up to HPM test recommendations in this paper will lead to a basic level of understanding the interactions between microwaves and DFCS.

VA-7-01 JTCG/AS-92-VR-006 **Unclassified**
MTL TR 92-64

Title: Design, Fabrication & Ballistic Testing of a Prototype Helicopter Modular Armor System

Issued: September 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John Graves

Performing Organization: AMTL (Renamed Army Research Laboratory, Materials Directorate)
Watertown, MA 02172-0001

Author: John P. Bird, Earl E. Conabee, John H. Graves* and Albert A. Anctil*

Abstract: A prototype system of aircraft modular armor designed to protect troops in the cargo bay of a next generation utility helicopter was fabricated and ballistically tested against armor piercing incendiary, ball, and high explosive incendiary projectiles. The modular armor system consisted of armor panels mounted on a composite airframe structure and a fuze shield to ensure premature detonation of high explosive threats. The response of the prototype modular armor system was determined for each threat. An assessment of the airframe section's ability to support both structural and flight loads was also made. The results of ballistic testing indicate that modular armor is a weight effective solution for defeat of armor piercing incendiary and high explosive incendiary projectiles at realistic stand off distances. A confidential addendum to this report has been printed under separate cover.

VC-0-02 **JTCG/AS-92-VR-004** **UNCLASSIFIED**
WL-TR-92-3106

Title: Advanced Vehicle Management System (AVMS) Architecture Studies - Final Report for Period June 1990 - June 1992

Issued: October 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Daniel Thompson, WL/FIGL

Performing Organization: Wright Laboratory
WPAFB, OH 45433

Author: Kenneth R. Gault, Carlos A. Bedoya, Chris A. Miller, John L. Mohr McDonnell Douglas Corporation McDonnell Aircraft Company St. Louis, MO 63266-0516

Abstract: This report describes the study results for the four major tasks of the Advanced Vehicle Management System (AVMS) Architecture Studies. The objective of the AVMS study is to identify the architectural concepts and the integrated development environment necessary for the next generation of vehicle management systems for advanced air vehicles. The first task of the program was to determine the AVMS requirements by performing a functional analysis of representative missions. AVMS requirements are derived for survivability, safety, redundancy, mean time between failure, computer resources, response time and probability of mission abort. The second major task was to define and evaluate potential AVMS architectures. A baseline and six candidate architectures are defined and evaluated in a comprehensive trade study. Two candidate architectures, one near-term and one post-1998, received high scores in the trade study. The third task was to define an integrated tool environment which could be used for the design, analysis, development, and verification of advanced VMS architectures. The fourth task was to quantify the benefits from the AVMS program, identify shortfalls needed for the integrated tool environment, processes, software, and architectures, and develop a roadmap to reduce the shortfalls.

VP-8-01 **JTCG/AS-92-VR-003** **CONFIDENTIAL**
NAWCWPNS TP 8076

Title: Ballistic Tests of Structural Concepts to Mitigate Damage and Reduce Fuel Leakage from Aircraft Tank - Duct Walls (U)

Issued: June1994 **DTIC AD #:** Not Issued
Sponsor: NAWCWPNS **SURVIAC File #:** Not Issued
Survivability and Lethality Division
China Lake, CA

Project Engineer: Les Throndson

Performing Organization: ASI Systems International
825 N. Downs Street
Ridgecrest, CA 93555

Author: Gary Burgner

Abstract: (U) The failure of jet engines as a result of fuel ingestion accounts for a substantial fraction of all combat aircraft losses. This report is a compilation of results of ballistic tests conducted on 24" x 24" panels embodying materials and structural concepts intended to mitigate damage to and reduce fuel leakage from aircraft inlet duct/fuel tank common walls. In addition to reducing the aircraft's fuel ingestion vulnerability, the successful approaches identified in these tests would be useful in reducing structural, drybay fire, and fuel depletion vulnerabilities. Over a three-year period, nearly 100 materials and structural concepts have been assessed. Panels have been supplied at no cost by contractors, in addition to being built in-house at NAWCWPNS's Weapons Survivability Laboratory (WSL).

VP-8-01 JTCG/AS-92-VR-002 **CONFIDENTIAL**
NAWCWPNS TP 8075

Title: Reducing Aircraft Vulnerability to Engine Inlet Fuel Ingestion (U)

Issued: June1994 **DTIC AD #:** Not Issued
Sponsor: NAWCWPNS **SURVIAC File #:** Not Issued
Survivability and Lethality Division
China Lake, CA

Project Engineer: Les Throndson

Performing Organization: ASI Systems International
825 N. Downs Street
Ridgecrest, CA 93555

Author: Gary Burgner

Abstract: (U) This report is a compilation of recommendations to reduce the vulnerability of jet aircraft to inlet fuel ingestion. The failure of engines as a result of inlet fuel ingestion accounts for a substantial fraction of all combat aircraft losses. Both "quick-dump" and "steady-flow" ingestion are discussed.

(U) Much of the information presented here is based on testing of late model turbofans under the Joint Live Fire (JLF) program. Those tests were conducted at the Naval Air Warfare Center Weapons Division (NAWCWPNS) using many innovative techniques, instrumentation, and photography. Many parameters associated with quick-dump ingestion were quantified for the first time. This quantification, combined with analysis of engine reactions to controlled ingestions, provides vastly improved understanding of the failure mechanisms and damage potential of the fuel ingestion threat.

VP-8-01 JTCG/AS-92-VR-001 **CONFIDENTIAL**
NAWCWPNS TP 7174

Title: Aircraft Engine Inlet Fuel Ingestion: What We Know About This Vulnerability (U)

Issued: September 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13506

Project Engineer: Les Throndson

Performing Organization: Naval Air Warfare Center Weapons Division
China Lake, CA 93555-6001

Author: Gary Burgner

Abstract: (U) This report is a compilation of what is known about the inlet fuel ingestion threat by the survivability/vulnerability community. It also presents new models to predict engine reaction. Both "quick-dump" and "steady-flow" ingestion are discussed. Recent testing, combined with analysis of the engine's reaction to the controlled ingestions, provides a vastly improved understanding of the failure mechanisms and damage potential of the fuel ingestion threat. Many engine failures are probably attributed to engine hits when the cause was actually inlet fuel ingestion. The military aircraft industry is gradually becoming aware of the seriousness of inlet fuel ingestion and is producing designs in which common tank-duct walls are being eliminated or designed to reduce the potential for ingestion. The invention and assessment of such approaches was a principal activity of JTCG/AS Project VP-8-01. This report and others produced under VP-8-01 are intended to promulgate awareness of the problem and possible solutions to the industry.

VF-0-01 JTCG/AS-91-VR-005 **UNCLASSIFIED**

Title: Fire/Explosion Protection Characterization and Optimization: Phase II - Alternative Agent Dry Bay Screening

Issued: **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: J. Michael Bennett, WL/FIVS

Performing Organization:
Wright Laboratory
WPAFB, OH 45433

Author: J. Michael Bennett

Abstract: Not received.

VS-9-01 JTCG/AS-91-VR-003 **UNCLASSIFIED**
NWC TP 7152

Title: Generic Fighter Wingbox Ballistic Tests

Issued: September 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13886

Project Engineer: Timothy A. Wise

Performing Organization: NWC (Renamed Naval Air Warfare Center, Weapons Division)
China Lake, CA 93555-6001

Author: Todd M. Anderson, Timothy A. Wise

Abstract: This report documents the ballistic tests of two all-composite wingboxes designed for the same loads as a generic fighter aircraft. The AS4 wingbox is an AS4/3501-6 material system, while the IM7 wingbox is an IM7/8551-7A material system. Both wingboxes were constructed at McDonnell Douglas Aircraft Company, (MCAIR) St. Louis, MO., as an industry research and development project. The test objectives were to investigate the effects of 23mm high explosive incendiary (HEI) rounds on all-composite wings, including the effects of load and hydraulic ram, and to examine the practicality of doing aircraft battle damage repairs (ABDRs).

VF-8-02 **JTCG/AS-91-VR-002** **UNCLASSIFIED**
NWC TP 7154, VOL II

Title: Evaluation of the Linear Fire Extinguisher (LFE) - Volume II: Water-Based Explosion Suppression Agents Ballistic Test Program

Issued: September 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 12371

Project Engineer: James R. Duzan

Performing Organization: Naval Weapons Center
China Lake, CA 93555-6001

Author: John F. Barnes and James R. Duzan

Abstract: The Linear Fire Extinguisher (LFE) system, developed by Systron Donner, is designed to enhance aircraft combat survivability by providing a self-contained, self-activated, quick-response method of protection against projectile-induced fires and explosions. The primary objective of this test phase (Phase V) was to provide empirical data allowing the evaluation of the LFE system's ullage explosion suppression performance using water-based suppression agents. The secondary objective was to collect data that would expand on earlier explosion suppression tests conducted during Phases I, II, and III. During Phases I, II, and IV, halogenated compounds were used as the extinguishing agents. During Phase III, in addition to Halon 1301, water and monoammonium phosphate powder were also used as extinguishing agents. Phase V expanded on this database by evaluating the following nine agents: distilled water; water and calcium chloride; water and ethehylene glycol; water and ethyl alcohol; water and aqueous film-forming foam; water and Halon 1301; water, aqueous film-forming foam, and Halon 1301; propane; and monoammonium phosphate powder and Halon 1301. The agents were stored in the LFE tube using nitrogen and/or carbon dioxide for tube pressurization.

TP-4-03 **JTCG/AS-91-VR-001** **UNCLASSIFIED**
SURVIAC-TR-89-024

Title: Penetration Characteristics of Advanced Engine Materials

Issued: September 1989 **DTIC AD #:** Not Issued
Sponsor: Ballistics Research Laboratory **SURVIAC File #:** TR89024
Aberdeen PG, MD

Project Engineer: Steven Polyak

Performing Organization: The SURVICE Engineerng Company
1003 Old Philadelphia Rd Ste 103
Aberdeen, MD 21001

Author: J. W. Foulk, B. E. Wheeler

Abstract: This report presents the final results of a JTCG/AS program to investigate ballistic penetration and damage characteristics of advanced materials used in past, present, and future military aircraft turbine engines. The initial program efforts involved reviewing engine component vulnerability, engine material requirements and trends, and existing engine test data. A detailed ballistic test program was then planned and conducted during March 1989 at the U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland. This testing consisted of Cal. 0.50 impacts against metal and composite materials being used or considered for use in fan and intake assemblies, compressor and turbine disks, and combustor casing applications.

JTCG/AS-90-T-004 UNCLASSIFIED
NWC TP 7129

Title: The Effectiveness of Ullage Nitrogen-Inerting Systems Against 30-mm High-Explosive Incendiary Projectiles

Issued: May 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: J. Hardy Tyson

Performing Organization: NWC (Renamed Naval Air Warfare Center, Weapons Division)
China Lake, CA 93555-6001

Author: J. Hardy Tyson and John F. Barnes

Abstract: This report presents the data and results of tests conducted at the Naval Weapons Center to evaluate the use of nitrogen in aircraft fuel tanks to produce an inert atmosphere in the ullage. The objective of these tests was to define the limits of nitrogen effectiveness against explosive reactions in a large ullage space.

Tests were conducted at simulated low, high, and ambient altitudes. Testing included the evaluation of inert atmospheres containing 9, 12, 15, and 21% oxygen and the effects of these atmospheric conditions on reactions produced by a low-energy J-57 engine igniter and a comparatively high-energy 30-mm HEI projectile. All tests were conducted in a 30 cubic foot steel simulator. A total of 65 tests were performed, including both control and inert tests.

VF-0-01 JTCG/AS-90-T-002 UNCLASSIFIED
WL-TR-91-3008

Title: Fire-Explosion Protection Characterization and Optimization Phase I - Data Analysis and Documentation

Issued: May 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 11748

Project Engineer: J. Michael Bennett

Performing Organization: WRDC/FIVST
WPAFB, OH 45433

Author: Dr. N. Albert Moussa and Mr. John J. Murphy, Jr.

Abstract: The effort discussed in this report was an investigation into advanced ullage protection methods for an aircraft fuel tank. The approach used was to first review the raw test data of three separate fire/explosion suppressant test programs to determine their relation to each other and their applicability to the overall effort. Second, based on the data review, determine the performance of each agent used in the tests, the concentration levels used and whether the test setup and conduct of each separate test influenced the results. Third, to identify any data trends and/or data voids that could possibly be clarified with additional testing, and fourth, to document the results of the overall effort. The test programs reviewed and discussed in this report are the results of gun-fire tests conducted intermittently over a seven-year span at the Aircraft Survivability Research Facility (ASRF), Wright-Patterson Air Force Base, Ohio and are presented in three phases. The objective of Phase A was to investigate the effects of venting, threat type, striker plate material and tank wall simulator (TWS) size on the effectiveness of Halon 1301 against 0.50 cal. API and 23-mm HEI projectiles under the conditions of higher temperatures and pressures anticipated in the F-16 fuel tank. The objective of Phase C was to expand the Phase A work on venting with a broader range of conditions, including nitrogen and halon inerting and 23-mm and 30-mm HEI projectiles.

VF-9-02 JTCG/AS-90-T-001 **UNCLASSIFIED**
WRDC-TR-90-3064

Title: Parker Reactive Explosion Suppression System (PRESS)

Issued: May 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13771

Project Engineer: J. Michael Bennett

Performing Organization: WRDC/FIVST
WPAFB, OH 45433

Author: Ken Bragg

Abstract: This report documents the work performed by the Parker Hannifin Corporation for the Flight Dynamics Lab and the JTCG/AS to optimize and perform proof-of-concept tests of the Parker Reactive Explosion Suppression System (PRESS). This innovative system is designed to be installed in aircraft fuel tanks and react to and suppress fuel tank explosions. It consists of an optical detector, transmission lines and a suppression tube(s) containing a water/brine solution. This system is designed to respond within a few milliseconds to engage the flame front and reduce pressures below damage causing levels. After detection, the transmission lines transmit a signal to the suppression tube, which initiates an exploding bridgewire circuit. This, in turn, initiates a detonating cord and propellant internal tube, creating a high pressure expulsion force to expel the adjacent bladder filled with water. The water exits through orifice holes, is transmitted through radial channels in the external nozzles and released as 5-micron-thick sheets. These sheets break up into 10-micron droplets which absorb thermal energy released by the explosion. This process occurs in its entirely within a few milliseconds. The proof-of-concept tests have shown the system to successfully reduce the over pressure created by a 23-mm HEI simulator detonated within an explosive propane air mixture in an experimental tank.

TF-8-02 JTCG/AS-89-T-006 **UNCLASSIFIED**

Title: Evaluation of the Linear Fire Extinguisher (LFE) - Volume I: Explosion Suppression and Dry Bay Fire Suppression Ballistic Test Program

Issued: September 1989 **DTIC AD #:** B139127
Sponsor: JTCG/AS **SURVIAC File #:** 7457

Project Engineer: John F. Barnes

Performing Organization: Naval Weapons Center
China Lake, CA 93555-6001

Author: John F. Barnes

Abstract: The linear fire extinguisher (LFE) is a self-activated protection system designed to enhance aircraft combat survivability by providing protection against projectile-induced fires. A four-phase ballistic test series was conducted to evaluate the potential use of the LFE as an ullage explosion suppression system and expand on earlier dry bay fire suppression testing. A 10 cubic foot wing fuel tank simulator and a 30 cubic foot fuselage fuel tank simulator was used for explosion suppression testing. A 75 cubic foot dry bay simulator with up to 23% clutter installed was used for fire suppression testing. The primary threat used was the 30-mm high-explosive incendiary (HEI) projectile. However, limited testing with the .50-cal armor piercing, 12.7-mm armor piercing incendiary and 23-mm HEI was also conducted. A total of 133 tests were completed in this test series.

TF-5-04 JTCG/AS-89-T-005 **UNCLASSIFIED**
USAAVSCOM TR 89-D-16

Title: Aircraft Fuel System Fire and Explosion Suppression Design Guide

Issued: February 1990 **DTIC AD #:** Not Issued
Sponsor: U. S. Army Aviation Technology Directorate, Ft. Eustis, VA **SURVIAC File #:** 12469

Project Engineer: Harold Holland, AATD

Performing Organization: The SURVICE Engineering Company
1003 Old Philadelphia Rd Ste 103
Aberdeen, MD 21001

Author: D. W. Mowrer, R. G. Bernier, W. Enoch, R. E. Lake, W. S. Vikestad

Abstract: This study was sponsored by the Fuel Committee of the JTCG/AS to obtain an up-to-date review of, and guidance toward, usage of techniques or materials which would contribute to the elimination of, or reduction of, the fuel fire/explosion hazard resulting from ballistic impacts on aircraft. While fuel fire/explosion is a primary hazard, there are other considerations which require concurrent examination, as they can be just as responsible for aircraft loss. There have been similar guides of various types published in the past, but for the most part they were oriented to vulnerability analysts. This Design Guide is specifically oriented to the fuel system designer and as such, addresses the vulnerability aspect from the design viewpoint rather than the vulnerability analysis aspect.

Appendix C contains the Working Data Base in two parts for this effort.

TF-8-02 JTCG/AS-89-T-004 **UNCLASSIFIED**

Title: Critical Review of Ullage Code

Issued: September 1989 **DTIC AD #:** B137599L
Sponsor: JTCG/AS **SURVIAC File #:** 04705

Project Engineer: Gary Burgner

Performing Organization: Naval Weapons Center
China Lake, CA 93555-6001

Author: N. A. Moussa

Abstract: There have been a number of efforts in the past to generate a computer code to predict the vapor composition in an aircraft tank ullage. The most recent and wide-spread of such codes is called ULLAGE. The effort documented in this report provides a critical review of ULLAGE and a discussion of related studies. Major shortcomings and limitations of ULLAGE are identified and ways of improving them are illustrated. Recommendations are presented for developing a more accurate code, that would also apply over a broader range of conditions than ULLAGE.

TS-6-02 JTCG/AS-89-T-003
WRDC-TR-89-3066

UNCLASSIFIED

Title: Advanced Wing Skin Material Evaluation

Issued: December 1988
Sponsor: JTCG/AS

DTIC AD #: Not Issued
SURVIAC File #: 4045

Project Engineer: Czarnecki, Gregory J.

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: Czarnecki, Gregory J.

Abstract: When a composite wing's integral fuel tank is impacted by a high velocity projectile, hydrodynamic ram combines with projectile damage, forcing delaminated material into the airflow stream.

Sensitivity studies, conducted by the Flight Dynamics Laboratory at Wright Patterson Air Force Base, proved high-speed airflow (400 knots) over battle damaged composite surfaces significantly increases the level of initial damage. Protruding fibrous material is torn back toward the wing's trailing edge. Results of studies to reduce or eliminate the effects of high-speed airflow over battle damaged surfaces were reported in AFWAL-TR-87-3090 and AFWAL-TR-88-3086. In a second program to reduce the effects of airflow, the material's inherent fracture toughness was relied upon. Materials chosen were high-temperature toughened bismaleimide and thermoplastics. Composite panels were fabricated and ballistically tested with 23mm API projectiles. The material's relative merit with respect to battle damage resistance/ tolerance was evaluated.

TS-8-01 JTCG/AS-89-T-002
AFWAL-89-3006

UNCLASSIFIED

Title: A Survey of Analysis Techniques to Predict Residual Properties of Ballistically Damaged Aircraft Structures

Issued: April 1989
Sponsor: JTCG/AS

DTIC AD #: Not Issued
SURVIAC File #: 10238

Project Engineer: Greg Czarnecki

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: Moon, Young In and Falugi, Michael

Abstract: The report documents a survey of analysis techniques to predict residual strength and fracture control capabilities for ballistically damaged aircraft structures. It provides recommended design guidelines that will enhance the survivability of composite structures used in future aircraft. Also included in this report are results of an extensive literature survey in areas of: ballistic threats, ballistic vulnerability of composite structures, and applications of analysis methods and recommendations for improving the Hydraulic Ram Structural Response (HRSR) Computer Code.

TS-2-03 JTCG/AS-89-T-001 **UNCLASSIFIED**
AFWAL-TR-89-3010

Title: Survivability of Integral Skin/Spar Design to Hydrodynamic Ram

Issued: March 1989 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 10429

Project Engineer: Oetting, David J.

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: Oetting, David J.

Abstract: A major concern in the development of composite integral fuel tanks is the lack of damage tolerance to hydrodynamic ram pressures resulting from ballistic damage. This program was established to investigate this phenomenon. The investigation of structural response of graphite/epoxy panels to hydrodynamic ram damage was accomplished in three parts. The first part dealt with the comparison of the damage response of aluminum panels to that of graphite/epoxy panels. The second part dealt exclusively with hydrodynamic ram technology as it applies to graphite/epoxy. The last part investigated the damage response of various skin/spar joints and their tolerance to hydrodynamic ram.

TM-4-03.1 JTCG/AS-88-T-002 **UNCLASSIFIED**

Title: Severe Thermal Environment Protection System (STEPS), JP-5 Pool Fire Tests

Issued: September 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Linda Haynes, NWC, Code 3386

Performing Organization: Naval Weapons Center
China Lake, CA 93555-6001

Author: Linda Haynes, NWC, Code 3386

Abstract: Wire bundles, representative of the construction of those found in F-18, were placed in thermal protective sleeving and powered. These bundles were tested in an uncontrolled JP-5 pool fire to determine how long they could survive under thermal conditions. The results of the four tests are contained in this report.

VA-7-01 MTL TR 90-11 **UNCLASSIFIED**

Title: Development of Helicopter Modular Armor Systems and Installation Techniques

Issued: March 1990 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 3198

Project Engineer: John Graves

Performing Organization: AMTL (Renamed Army Research Laboratory, Materials Directorate)
Watertown, MA 02172-0001

Author: R. J. Bristow and W. M. Herlin, and A. A. Anctil and J. H. Graves

Abstract: The objective of this contract was to develop a representative modular armor system for use on a utility rotary wing aircraft to protect critical components such as troops against nonnuclear threats and AP and HE projectiles and to evaluate the effect of modular armor on aircraft survivability and performance. Modular armor was designed to be installed rapidly for hostile operations, replaced when battle damaged, and removed when not needed. A confidential addendum to this report is being printed under separate cover.

TF-5-02 JTCG/AS-87-T-006 **UNCLASSIFIED**

Title: Compartmentalized Aircraft Wing Tank Active Ullage Explosion Suppression Tests

Issued: July 1988 **DTIC AD #:** B126482
Sponsor: JTCG/AS **SURVIAC File #:** 09700

Project Engineer: J. Hardy Tyson

Performing Organization: Naval Weapons Center
China Lake, CA 93555-6001

Author: J. Hardy Tyson

Abstract: This report documents the second in a series of gun fire tests evaluating the performance of an active ullage explosion suppression system. Even though the system as tested had a significant effect of the peak pressure and rise time of the pressure, based on our acceptance criteria of keeping the peak pressure below 10 psig, the system did not work. It is recommended that for future work in active ullage explosion suppression, employing Halon, the transportation distance of the Halon should be minimized. This would directly affect the time of the arrival of the suppressant and it is felt that suppression could be achieved. Appendix C includes pressure data from all tests.

TS-5-04 JTCG/AS-87-T-005 **UNCLASSIFIED**
AFWAL-TR-88-3014

Title: Survivability Characteristics of Composite Compression Structures

Issued: May 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 9684

Project Engineer: Avery, J. G.

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: Allen, M. R., Avery, J. G.

Abstract: This report presents work accomplished from February 1984 to May 1988. The program objectives were to develop new design concepts and to verify analysis methods for improved survivability of composite compression structures to ballistic weapon threats. The approach to achieve these objectives included a two part program to resolve data deficiencies and incorporate program results into design practice through development of design guidelines. Part one established and compared the survivability performance of advanced composite materials and survivable concepts by testing flat panels under compression loading against the advanced survivable designs. Part two extended and validated these results for application to full-scale multi-loadpath structure by ballistic testing three survivable compression covers on a single box-beam component. All four covers were impacted with three fragments under load to 0.0016 in/in strain, cyclic loaded and then statically loaded to either failure or 0.004 in/in strain level.

JTCG/AS-87-T-004 UNCLASSIFIED

Title: A Ballistic Evaluation of Light-Weight Void Fillers

Issued: October 1987 **DTIC AD #:** B117102
Sponsor: JTCG/AS **SURVIAC File #:** 09248

Project Engineer: M. Mercer

Performing Organization: Naval Weapons Center
China Lake, CA 93555-6001

Author: M. Mercer

Abstract: This report documents a series of tests evaluating 16 different powder systems for aircraft dry bay fire protection. There were two phases of testing. Phase I consisted of 49 ballistic tests using a dry bay simulator, and phase II tested the ruggedness of each system to handling. The threat used during phase I testing was the 23-mm HEI-T.

TS-4-02 JTCG/AS-87-T-002 UNCLASSIFIED
NRL Memo Report 6048

Title: High Intensity Laser Irradiation Effects on Double-Lap and Step-Lap Graphite/Epoxy to Titanium Adhesively Bonded Joints

Issued: March 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 01453L

Project Engineer: Stonsifer, Fred R.

Performing Organization: Naval Research Laboratory
Washington, DC 20375-5320

Author: Jones, Harry N.; Stonsifer, Fred R.; Chang, Chinee I.; Wissinger, Gregory W.

Abstract: Increased use of composite materials in aircraft structures necessitates joints between metallic and composite components. While the strength degradation effects of high intensity laser irradiation of both metals and composites have been studied in the past, this has not been done on any of the bonded joint designs that now exist in many aircraft structures. Two joint designs, a step-lap and a double step-lap typically used in airframe construction were chosen for study. The primary objective of the tests discussed in this report was to make observations on failure modes of these joints when exposed to high intensity heat sources and provide a basis for development of a failure model. These tests provide a starting point for a more detailed understanding of the failure mechanisms involved and a basis for making a rational vulnerability assessment.

TS-4-05 JTCG/AS-87-T-001 **UNCLASSIFIED**
MTL TR 87-43

Title: Degradation in Structural Load Capacity of Bonded Composite Aircraft Joints Due to Failure of the Adhesive Bond as a Result of Ballistic Impact

Issued: August 1987 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 8715

Project Engineer: Muldoon, Robert A.

Performing Organization: Army Material Technologies Laboratory, Watertown, MA 02172-0001

Author: Muldoon, Robert A.

Abstract: The results of a preliminary experimental program designed to determine the degradation in the structural load capacity of bonded composite aircraft joints due to failure of the adhesive bond resulting from ballistic attack by fragments produced from the detonation of a 23mm HEI-T projectile are presented. An analysis of the fragment spray produced indicated that the most lethal fragment could be reproduced by the .30 cal. FSP round which is used exclusively for ballistic tests performed in this study. 7075-T73 aluminum clad celion G-50 graphite/epoxy composite material was used in the test program. The aluminum plate was bonded front and back to the composite using EA 9309 adhesive. A range of impact velocities was investigated for applied loads of 1,000, 5,000 and 10,000 lbs. The reduced structural load capacity of the specimens as measured after ballistic impact is plotted and discussed.

TF-6-09.0 JTCG/AS-86-T-001 **UNCLASSIFIED**

Title: Hybrid Composite Response to Hydraulic Ram

Issued: October 1986 **DTIC AD #:** A178750
Sponsor: JTCG/AS **SURVIAC File #:** 07764

Project Engineer: Todd Anderson

Performing Organization: Naval Weapons Center China Lake, CA 93555-6001

Author: Scott Lang; Jamie Childress; Todd Anderson

Abstract: Hydraulic Ram is a major damage mechanism in fuel tanks that are impacted by projectiles. Composite materials have proved vulnerable to hydraulic ram in ballistic testing. Hybridizing graphite/epoxy structures with materials such as fiberglass, nylon, or Kevlar shows promise for reducing the vulnerability of composite structures to hydraulic ram. This report presents the results of ballistic testing of small test panels hybridized with several materials in several different configurations. Many configurations and materials provide significant improvement over baseline graphic panels and are recommended for further testing.

TF-3-04 JTCG/AS-85-T-002 **UNCLASSIFIED**

Title: Ram Tolerant Fuel Tank Components

Issued: February 1986 **DTIC AD #:** B110522L
Sponsor: JTCG/AS **SURVIAC File #:** 7872

Project Engineer: Jamie Childress

Performing Organization: Naval Weapons Center China Lake, CA 93555-6001

Author: Jamie Childress, Eric Lundstrom

Abstract: Aircraft fuel systems were subjected to hydraulic ram by armor piercing and high explosive projectiles. Fuel tank components were examined after testing for hydraulic ram damage.

TC-3-03.0 JTCG/AS-83-T-004 UNCLASSIFIED

Title: Aircraft Hydraulic Centrum Concept: Design and Survivability Analysis

Issued: March 1986 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 5697

Project Engineer: Tor W. Jansen, NADC (deceased)

Performing Organization: Naval Air Development Center
Warminster, PA 18974-9000

Author: C. E. Knezek, J. E. Garner, and J. K. Trotter, General Dynamics Corp.

Abstract: The Navy Armored Hydraulic Centrum Investigation analyzes the impact of utilizing centrum concepts in hydraulic system design concepts to yield increased aircraft survivability. The program objectives are: (1) develop centrum design concepts that increase survivability, (2) evaluate these concepts by quantifying survivability improvements, and (3) recommend hydraulic system design techniques that will increase survivability. The approach taken consisted of the following tasks: (1) Development of a baseline configuration that represents a current technology aircraft hydraulic system. (2) Development of two hydraulic system design options incorporating hydraulic-centrum system features that increase aircraft survivability. (3) Evaluation of the relative merit of these options by comparison to the baseline configuration. (4) Preparation of a design recommendations report.

TC-0-01.0 JTCG/AS-83-T-003 UNCLASSIFIED

Title: Survivability Assessment and Design Guide for Light Weight Hydraulic Systems (8000 psi)

Issued: May 1984 **DTIC AD #:** B093440
Sponsor: JTCG/AS **SURVIAC File #:** 05804

Project Engineer: R. B. Olsen

Performing Organization: Naval Air Development Center
Warminster, PA 18974-9000

Author: R. B. Olsen

Abstract: Five hydraulic systems were analyzed using the quick analysis method to determine probability of kill data for two ground attack missions. The baseline system was the A-7E aircraft 3000 psi hydraulic system. An equivalent 8000 psi baseline system and three highly survivable systems were defined. Conversion of the baseline 3000 psi system to the equivalent 8000 psi system resulted in an average of 39.7 percent reduction in probability of kill for flight controls. Use of 8000 psi operating pressure with electro-hydraulic poser packs resulted in an average reduced Pk of 91.6 percent for flight controls compared to the baseline 3000 psi system.

WU 505-08-21 JTCG/AS-82-T-002 **UNCLASSIFIED**

Title: Development and Testing of Dry Chemicals in Advanced Extinguishing Systems for Jet Engine Nacelle Fires

Issued: February 1983
Sponsor: Naval Weapons Center
China Lake, CA 93555

DTIC AD #: A174406
SURVIAC File #: 08867

Project Engineer: W. E. Collier, Jr. NWC

Performing Organization: Dept of Chemistry and Civil Engineering
San Jose State University
San Jose, CA

Author: R. L. Altman, A. C. Ling, L. A. Mayer, et. al.

Abstract: This document reports an experimental study of the effectiveness of dry chemical in extinguishing and delaying re-ignition of fires resulting from hydrocarbon fuel leaking onto heated surfaces such as can occur in jet engine nacelles. The commercial fire extinguishant dry chemicals tried were, for example, sodium and potassium bicarbonate, carbonate chloride, and carbamate (monnex) but we have also tested other metal-halogen and metal-hydroxycarbonate compounds prepared in our own laboratories. Given in this report are: synthetic and preparative procedures for new materials developed; a new concept of fire-control by dry chemical agents; descriptions of experimental assemblages to test dry chemical fire extinguishant efficiencies in controlling fuel fires initiated by hot surfaces; comparative testing data for more than 25 chemical systems in a static assemblage with no airflow across the heated surface, and similar comparative data for more than 10 compounds in a dynamic system with airflows up to 350 ft/sec; and recommendations for future work with one system that fulfills all requirements delineated by the sponsoring agency, and which has been tested in both the static and dynamic assemblages with both methodologies confirming it as the most effective system by comparison with other materials tested.

TC-0-42.0 JTCG/AS-82-T-001 **UNCLASSIFIED**

Title: Evaluation of Flight Control Signal Lines

Issued: April 1983
Sponsor: JTCG/AS

DTIC AD #: B090524L
SURVIAC File #: 04263

Project Engineer: Tor W. Jansen (deceased)

Performing Organization: Naval Air Development Center
Warminster, PA

Author: W. C. Mangum, W. H. Lewis, T. W. Jansen

Abstract: Survivability of flight control signal lines between pilot and flight control surfaces is investigated. The threat environment considered was ballistically caused fires specifically on fly-by-wire aircraft such as the F-16 and F-18 and resulting survivability of command and feedback wires. Fluidic and fiber optics systems are investigated for use as backup flight control signal lines and their survivability when exposed to the fire environment.

VA-1-02F JTCG/AS-82-SM-001
ASD TR-82-5018

UNCLASSIFIED

Title: Aircraft Combat Damage Repair Estimating Procedures

Issued: August 1982
Sponsor: JTCG/AS

DTIC AD #: B072719L
SURVIAC File #: 03474

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: J. J. Flowers, D. H. Kovatch, and R. L. Day, Jr.

Abstract: This report documents the first phase of a three phase program to develop procedures for estimating combat damage repair time of inflight and parked aircraft. The objectives of this phase were to: (1) review survivability user models that require repair related input data, (2) evaluate an existing repair time data base for completeness and consistency, (3) review mission essential subsystem criteria for acceptable levels of degraded operation, (4) assess repair difficulty in a chemical/biological warfare environment, (5) consider damage assessment and repairability of composite materials and (6) recommend a methodology for a computerized data base for development in Phase II and validation in Phase III.

TA-7-52 JTCG/AS-81-T-003
TR 81-228

UNCLASSIFIED

Title: 57mm High-Explosive Projectiles Threat Program Test Results

Issued: August 1982
Sponsor: JTCG/AS

DTIC AD #: B059206L
SURVIAC File #: 03046

Project Engineer: Jamison, Michael R.

Performing Organization: Naval Surface Warfare Center
Dahlgren, VA 22448

Author: Jamison, Michael R.

Abstract: A 57mm test weapon and 13 rounds of Soviet model UOR-281 ammunition were evaluated. Nose spray fragmentation was collected and analyzed, and various aluminum and titanium armor plates were impacted by fragmentation in a series of dynamic arenas. Projectile velocity decay and blast profile information were also obtained.

TF-1-02 JTCG/AS-81-T-002 **CONFIDENTIAL**

Title: Testing of Powder Packs and Powder-Filled Structures for Aircraft Fire Protection (U)

Issued: March 1981 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 3379

Project Engineer: C. Pedriani

Performing Organization: U. S. Army Applied Technology Laboratory
Ft. Eustis, VA

Author: C. Pedriani

Abstract: (U) The Army is pursuing the development of powder packs and powder-filled structural panels to prevent fires in dry bays adjacent to helicopter fuel tanks which occur as a consequence of an API or HEI ballistic impact. These tests emphasized the identification of fabrication techniques for honeycomb core sandwich panels which contain a fire-suppression powder within the honeycomb so that fire protection can be incorporated into the basic structural element common to many helicopter fuel tanks. This effort was conducted to obtain test data to assist in expanding the potential use of the powder pack concept to other aircraft fuel tank constructions. Twenty-eight tests were conducted using a variety of powder pack and powder-filled structural test specimens on simulated and integral and fuselage fuel tanks exposed to API and HEI-T projectiles with airflow conditions of 20 and 120 knots. Aluminum oxide powder and Monnex were used in the tests.

JTCG/AS-80-T-003 **UNCLASSIFIED**

Title: Development of a Proposed Mil Spec for Survivable Aircraft Structures (Non-nuclear) and Supporting Data for the Proposed Mil Spec

Issued: November 1980 **DTIC AD #:** B057402L
Sponsor: JTCG/AS **SURVIAC File #:** 3011

Project Engineer: George Ducker

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: J. Avery and W. Herlin, Boeing Seattle

Abstract: This report presents the results of a program to develop a proposed Military Specification for Survivable Aircraft Structures. It was originally prepared as Volume III of Boeing Document No. D180-25766. Volume I was the proposed Military Specification. Volume II was the supporting Rationale and Background which presented the rationale for each paragraph of the specification. It also provided a viable management decision-making tool in that weight penalties for various degrees of survivability are identified. This report contains a summary of all the pertinent data used in the program, and a step-by-step description of the work performed in implementing the program. The proposed military specification contains the requirements for providing structural survivability to the effects of ballistic damage from projectile or fragment impacts. It is applicable to each phase of aircraft development.

JTCG/AS-80-V-003 **UNCLASSIFIED**

Title: A Pictorial Review of USAF Aircraft Battle Damage

Issued: December 1981 **DTIC AD #:** B082156
Sponsor: JTCG/AS **SURVIAC File #:** 03334

Project Engineer: Don Voyls

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: D. Voyls, AFWAL

Abstract: This report is a photographic compilation of combat damages to U. S. Air Force aircraft in the Southeast Asia Conflict.

JTCG/AS-80-T-001 UNCLASSIFIED
TR-80-3042

Title: Aircraft Fuel Tank Responses to High Velocity Cubical Fragments

Issued: October 1980 **DTIC AD #:** B050852L
Sponsor: JTCG/AS **SURVIAC File #:** 2850

Project Engineer: Greg Gandee

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: L. A. Cross, University of Dayton Research Center

Abstract: Failure data, displacement data, and pressure data were obtained from laboratory experiments for the impact of steel cubes on water-backed aluminum panels. The panels were made from 2024-T3 and 7075-T6 aluminum varying in thickness from 0.032 to 0.250 inches. The steel projectiles were of 90, 120, and 180 grain weights. The panels were either of plain metal or protected on their rear surfaces by tear-resistant bladders, self-sealing bladders with backing board, or a 10mm thick foam. The data gathered on the damage threshold velocity for graphite-epoxy and aluminum panels backed by stiffeners obtained from earlier studies was also collected and is presented in this report for comparison purposes.

VA-7-02N JTCG/AS-79-V-006 SECRET

Title: Survivability Analyst Guide for Soviet Naval Nonnuclear Surface-to-Air Missile Systems Characteristics (Current and Projected) (U)

Issued: 1979 **DTIC AD #:** C030934L
Sponsor: JTCG/AS **SURVIAC File #:** 2992

Project Engineer: Unknown

Performing Organization: Naval Air Development Center
Warminster, PA

Author: Unknown

Abstract: (U) Threat characteristics of principal current and projected ship-to-air guided missiles are presented. These threat data inputs are for vulnerability, survivability, and effectiveness analysis in support of U.S. aircraft programs. For each missile threat discussed in the study, information is included on the characteristics of the missile system and the radar used with the missile system.

VA-6-04F JTCG/AS-79-V-004 UNCLASSIFIED

Title: Reduction of Quantal Data of Small Sample Sizes

Issued: April 1980 **DTIC AD #:** B046434
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: J. Becsey

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: J. Becsey

Abstract: In certain areas of destructive testing, test samples are exposed to various levels of stimulus or stress. In these tests, samples respond to the applied stress with either survival or failure. Most often the responses of the samples are instant or very complex and the exact level of stress causing failure cannot be measured or precisely determined. Therefore, special statistical methods must be used to reduce the test results. These methods are often limited to tests of large sample sizes. This note presents a novel data reduction method which alleviates this need and is very appropriate for those cases where only a limited number of samples are available for testing. A computer oriented approach, including a Fortran-coded and a desk calculator version, is described in detail.

VA-6-02A JTCG/AS-78-V-007 **UNCLASSIFIED**
3270-88/BUF-13

Title: Simplified Techniques for Vulnerability Tradeoff Analyses

Issued: August 1979 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 2621

Project Engineer: N. Morse

Performing Organization: Falcon Research and Development
One American Drive
Buffalo, NY 14225

Author: N. Morse, Art Stein

Abstract: This report provides a simplified technique for tradeoff evaluations suitable for use in the conceptual design stage of aircraft survivability. Choosing from among alternative passive defense measures for reduction of terminal ballistic vulnerability would, if all things were equal, lead one to choose the measure giving the largest reduction. However, the alternative designs usually have "penalties" in cost, weight, size or performance associated with them. Decisions then require tradeoff analysis. This report describes the extension of original developments in tradeoff methodology (which were concerned primarily with cost and weight penalties) to include speed and maneuver penalties. Methods for treating mixes of missions and/or threat weapons are also described.

VA-6-02 JTCG/AS-78-V-003 **SECRET**

Title: Preliminary Design External Blast Vulnerability Assessment Procedure (Volume I, Analyst Manual) (U)

Issued: August 1980 **DTIC AD #:** B052429
Sponsor: JTCG/AS **SURVIAC File #:** 2060

Project Engineer: Flowers, J.

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: Flowers, J., Bailey, R., Spann, G.

Abstract: (U) The External Blast Vulnerability Assessment Program provides traceable and repeatable methodology for prediction of whole aircraft damage due to external blast effects from nonnuclear weapons greater than 5 pounds in explosive weight. Arrays of reference and surface points are used to describe the overall aircraft configuration. These points reflect size, shape, and position of fuselage section, wings, stabilizers, engines, etc. Structural properties of the design are automatically selected from precoded data for existing example aircraft of similar construction, or are computed from user-specified information. The threat warhead is selected from precoded descriptions of existing air-to-air and surface-to-air projectile and missile weapons, or is specified by the user. Capabilities of the program were validated by comparing computed damage with actual results observed in whole aircraft tests conducted by the Royal Aircraft Establishment, Farnborough, England.

VA-6-04F **JTCG/AS-77-V-004** **UNCLASSIFIED**
TR-77-9

Title: Military Aeronautical Systems Materials Matrix Study - Volume II, Pictorial and Tabular Presentations of Vehicle Skin Material Data

Issued: April 1980 **DTIC AD #:** B020942
Sponsor: JTCG/AS **SURVIAC File #:** 1943

Project Engineer: R. Roesner, ASD

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: Beaupain, H. P., Crowder, P. A., Wilbert, R. E., Zimmer, G. T.

Abstract: This report presents the results of a comprehensive technical survey to identify, describe, and summarize the material composition of the external surface regions of U. S. military aircraft and to compile the associated material property and laser response data for those materials. Results are summarized in Volume I and detailed vehicle surface material definition (type, thickness area, location) is presented in volume II as a design data source.

VA-6-04F **JTCG/AS-77-V-003** **CONFIDENTIAL**
TR-77-9

Title: Military Aeronautical Systems Materials Matrix Study - Volume I Summary and Results (U)

Issued: April 1980 **DTIC AD #:** C011348
Sponsor: JTCG/AS **SURVIAC File #:** 2011

Project Engineer: R. Roesner, ASD

Performing Organization: Aeronautical Systems Division, Wright-Patterson AFB, OH

Author: Beaupain, H. P., Crowder, P. A., Wilbert, R. E., Zimmer, G. T.

Abstract: (U) This report presents the results of a comprehensive technical survey to identify, describe, and summarize the material composition of the external surface regions of U. S. military aircraft and to compile the associated material property and laser response data for those materials. Results are summarized in Volume I and detailed surface material definition is presented in Volume II as a design data source.

TEAS 5.1.6.6 **JTCG/AS-77-V-001** **CONFIDENTIAL**
ASD-TR-7719

Title: Aircraft Fuel Tank Environment/Threat Model for Fire and Explosion Vulnerability Assessment (Volume I, Data Search and Analysis) (U)

Issued: May 1980 **DTIC AD #:** C021916L
Sponsor: JTCG/AS **SURVIAC File #:** 1912

Project Engineer: Unknown

Performing Organization: Air Force Aero Propulsion Laboratory

Author: Mahood, L., Custard, G. H., Pascal, A.

Abstract: (U) This report summarizes the results of Task I of a four-task program to develop an environment and threat model for fire and explosion vulnerability assessment of combat aircraft fuel tanks. An extensive literature search was performed of relevant modern and historical data, particularly on ballistic tests of actual or replica aircraft fuel tanks.

TEAS 5.1.6.7 JTCG/AS-75-V-004 CONFIDENTIAL

Title: Vuln. of A-7E Aircraft to Selected Nonexplosive Proj. Threats (U); Volume I - Analysis Input Data and Geo. Model Desc.. (U); Volume II - Vuln. Area Analysis Results (U)

Issued: February 1977 **DTIC AD #:** C003043L
Sponsor: JTCG/AS **SURVIAC File #:** 1922

Project Engineer: M. C. Mitchell

Performing Organization: Naval Air Development Center
Warminster, PA

Author: M. C. Mitchell and D. G. Tauras

Abstract: (U) This report comprises two volumes, each under separate cover. Volume I contains all analysis input data and information and A-7E geometric model description. Volume II contains the complete and detailed vulnerable area analysis results. A-7E vulnerable areas were computed for 26 aircraft attack aspects with threat impact velocities ranging from 500 to 3500 ft/sec. The threats considered were four small arms Soviet ground-to-air armor piercing incendiary projectiles. The analysis shows that the A-7E does not fully exploit the vulnerability reduction features offered by the present state-of-the-art. The vulnerability of the A-7E to threats considered can be reduced by installing: (1) Internal foam in all fuel tanks, (2) void-filling (where possible) around all fuel tanks, (3) .50 caliber bottom and side armor around cockpit, and (4) .50 caliber bottom and side armor around engine.

TEAS 5.1.6.7 JTCG/AS-75-V-003 CONFIDENTIAL
73106-50

Title: Vulnerability Analysis of the A-4M and AV-8A Aircraft to Selected Threats (U)

Issued: December 1976 **DTIC AD #:** C011172L
Sponsor: JTCG/AS **SURVIAC File #:** 1092

Project Engineer: M. C. Mitchell

Performing Organization: Naval Air Development Center
Warminster, PA

Author: M. C. Mitchell and D. G. Tauras

Abstract: (U) This report describes the vulnerability analysis of the A-4M and AV-8A aircraft. Vulnerable areas are developed for the six major attack aspects of each aircraft. The selection of the threats, kill level, and aircraft configuration was based on the results of other analyses previously performed in the close air support area, thus making these analyses compatible.

TEAS 5.1.2.12 JTCG/AS-74-T-009 CONFIDENTIAL

Title: Vulnerability Tests on Operating Power Train Components of an Intermediate-Size Helicopter (U)

Issued: September 1974 **DTIC AD #:** ALA
Sponsor: JTCG/AS **SURVIAC File #:** 1047

Project Engineer: Unknown

Performing Organization: Ballistics Research Laboratory
Aberdeen PG, MD

Author: Unknown

Abstract: (U) Presents results of 14.5- and 23-mm AP projectile firing tests against the forward, central, and aft transmissions, drive tubes, end fittings, and hanger bearings of CH-21 aircraft operated under power in a tied-down configuration.

TEAS 5.1.6.2 JTCG/AS-76-V-006 **UNCLASSIFIED**

Title: Failure Prediction for Damaged Aircraft Structures

Issued: 1976 **DTIC AD #:** B031388L
Sponsor: JTCG/AS **SURVIAC File #:** 2309

Project Engineer: William J. Stronge

Performing Organization: Naval Weapons Center
China Lake, CA

Author: William J. Stronge

Abstract: A general method is presented for assessing the effects of aircraft structural damage. Analyses of damaged structures subjected to flight loading conditions are used to determine the residual performance envelope of any particular aircraft. By comparing the residual performance with required performance for a particular mission scenario, kill levels can be established for any prescribed damage.

TEAS 5.1.6.2 JTCG/AS-76-V-004 **UNCLASSIFIED**

Title: Aircraft Vulnerability Assessment Methodology, Volume 1 - General

Issued: July 1977 **DTIC AD #:** B021021
Sponsor: JTCG/AS **SURVIAC File #:** 1167

Project Engineer: D. W. Mowrer

Performing Organization: Ballistics Research Laboratory
APG, MD

Author: D. W. Mowrer, R. D. Meyerhofer, and R. N. Schumacher

Abstract: This report is being published in twelve volumes. Volume I presents the general problems of aircraft vulnerability assessment and the methodologies currently being used in vulnerability studies. Volumes II through XI present discussions of the vulnerability of each of the aircraft systems to nonnuclear threats, procedures used for assessing the vulnerability test data for various components, and existing vulnerability data gaps. Volume XII contains a bibliography of published reports (mainly by Army agencies) pertaining to the vulnerability of aircraft and the methodology for assessing the vulnerability of aircraft.

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SM-8-18 JTCG/AS-94-M-008 **UNCLASSIFIED**
ASC/XREWS-TR-94-2

Title: PIXPL3.0 User's Manual

Issued: March 1994 **DTIC AD #:** Not Issued
Sponsor: U. S. Army Research Laboratory, (AMSRL-SL-BA) and U. S. Air Force Aeronautical Systems Center (ASC/XREWS) **SURVIAC File #:** Not Issued

Project Engineer: Steve Polyak

Performing Organization: ASI Systems International
838 N. Eglin Parkway, Suite 421
Fort Walton Beach, FL 32547-2592

Author: Edward D. Aitken and Susan Long Jones

Abstract: PIXPL3.0 is a version of PIXPL specifically tailored to perform interactively on a 32-bit Personal Computer and work stations while retaining its compatibility with the CRAY Y-MP and VAX computers. When operating in the PC or work station environment, plot routines are written for a printer having Adobe PostScript® lanquage installed.

SM-8-18 JTCG/AS-94-M-007 **UNCLASSIFIED**
ASC/XREWS-TR-94-1

Title: CONVERT3.0 User's Manual

Issued: March 1994 **DTIC AD #:** Not Issued
Sponsor: U. S. Army Research Laboratory, Surv./Lethal. Analysis Directorate and U. S. Air Force Aeronautical Systems Center (ASC/XREWS) **SURVIAC File #:** Not Issued

Project Engineer: Steve Polyak

Performing Organization: ASI Systems International
838 N. Eglin Parkway, Suite 421
Fort Walton Beach, FL 32547-2592

Author: Susan Long Jones and Edward D. Aitken

Abstract: The original CONVERT computer program is a modification of the RAWGEN computer program. The program has been maintained and updated to keep pace with the different platforms that have been introduced at Eglin and to the market in general. It has been adapted for the CRAY Y-MP 8/2128, a series of VAX computers, and subsequently modified and renamed CONVERT3.0 to operate on Personal Computers (PCs) and work stations.

SM-3-17 JTCG/AS-94-M-005 **SECRET NOFORN WINTEL**
ASC/XREWA-TR-94-1

Title: HAVE FACTOR Warhead Threat Performance Model (U)

Issued: APRIL1994 **DTIC AD #:** Not Issued
Sponsor: Aeronautical Systems Center (ASC/XREW) Eglin Air Force Base. FL 32542-5499 **SURVIAC File #:** Not Issued

Project Engineer: David Heckel

Performing Organization: ASI Systems International
838 N Eglin Parkway, Suite 421
Fort Walton Beach, FL 32547-2592

Author: Lillard E. Gilbert, (Lillard Research, Inc.)

Abstract: (U) This report documents the results from the HAVE FACTOR Missile Warhead Threat Characterization Program. The program includes the warhead design information, test, test data analysis and development of the fragment threat performance data array. This report provides fragment weight, shape, material, velocity and spacial dispersion information in a simple data array that defines the HAVE FACTOR warhead capability to generate an antiaircraft threat.

M-3-04/M-3-07 JTCG/AS-94-M-003 **UNCLASSIFIED**

Title: RADGUNS Antiaircraft Artillery Simulation Volume 3. Methodology and Design Manual – Version 1.9

Issued: 20 APRIL 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Dwight FitzSimons and Susan Olson

Performing Organization: US Army Foreign Science and Technology Center
Research and Analysis Directorate, Air Combat Division (IAFSTC-RAC)
220 Seventh St., NE, Charlottesville, VA 222901-5396

Author: Dwight FitzSimons, Dr. Robert Ramey, Susan Olson, Bill Holet, Charlotte Blair, Cheryl Knecht, Major Steve Satchwell, Captain Arnond Bustle, Steve Swier, Doug Bower, Traci Humes

Abstract: Methodology and design manual for RADGUNS. Contains descriptions of the methodologies used in the various RADGUNS weapon models and the design of the models.

M-3-04 JTCG/AS-94-M-002 **SECRET NOFORN**
M-3-07

Title: RADGUNS Antiaircraft Artillery Simulation Volume 2. Supplement to User Manual (U) – Version 1.9

Issued: 20 April 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13845

Project Engineer: Dwight FitzSimons and Susan Olson

Performing Organization: US Army Foreign Science and Technology Center
Research and Analysis Directorate, Air combat Division (IAFSTC-RAC)
220 Seventh St., NE, Charlottesville, VA 22901-5396

Author: Dwight FitzSimons, Susan Olson, Major Steve Satchwell, Steve Swier, Doug Bower

Abstract: (U) Supplementary data for RADGUNS User Manual (Volume 1). Contains classified data on weapon systems, aircraft, and jammers needed by the RADGUNS user.

M-3-04/M-3-07 JTCG/AS-94-M-001 **UNCLASSIFIED**

Title: RADGUNS Antiaircraft Artillery Simulation Volume I. User Manual – VERSION 1.9

Issued: 20 April 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13847

Project Engineer: Dwight FitzSimons and Susan Olson

Performing Organization: US Army Foreign Science and Technology Center
Research and Analysis Directorate, Air combat Division (IAFSTC-RAC)
220 Seventh St., NE, Charlottesville, VA 22901-5396

Author: Dwight FitzSimons, Dr. Robert Ramey, Susan Olson, Bill Holet, charlotte Blair, Cheryl Knecht, Major Steve Satchwell, Captain Arnold Bustle, Steve Swier, Doug Bower

Abstract: User manual for users of the RADGUNS simulation. Contains detailed instructions on the execution of the simulation and its use in gun effectiveness/aircraft survivability analysis.

SMART JTCG/AS-93-SM-020 **UNCLASSIFIED**

Title: A Report on Accreditation Procedural Requirements: Volume I - A Comparative Analysis of Tri-Service Accreditation Policies and Practices; Volume II - Information Requirements in Support of Accreditation

Issued: February 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: David Hall

Performing Organization: Computer Sciences Corporation
Dr. Paul Muessig, SMART Project Office
NAWC WPNS (Code C21806)
China Lake, CA 93555

Author: Dennis R. Laack, Computer Sciences Corp.

Abstract: The SMART Project is developing an efficient process for the verification and validation (V&V) and configuration management (C/M) of aircraft susceptibility models. In order to make the products of the SMART project most beneficial to model users, a study of accreditation requirements was undertaken. The study addressed both the accreditation procedures and information requirements. This report summarizes the findings of the study regarding accreditation procedures.

The principal findings are that the emerging service policies impose a significant bureaucratic burden on persons involved in model accreditation. This burden will require extra time and money to accredit models. In contrast, current accreditaion practices are relatively streamlined. This burden will require extra time and money to accredit a model. In contrast, current accreditation practices are relatively streamlined. However, they suffer from a lack on consistency from one organization to the next. Therefore, there is little confidence in the quality of many accreditation decisions. The report suggests an accreditation approach which maintains the efficiency of the current practices but requires development of guidelines for generating accreditation criteria and suggests establishment of an advisory body to assist in development of adequate criteria.

SM-9-12 JTCG/AS-93-M-012 **UNCLASSIFIED**

Title: Software User's Manual for the Advanced Low Altitude Radar Model (ALARM 3.0)

Issued: 16 August 93
Sponsor: Wright Laboratory
2241 Avionics Circle
WPAFB, OH 45433-7318

DTIC AD #: Not Issued
SURVIAC File #: Not Issued

Project Engineer: Robert Ehret (WL/AAWA-1)

Performing Organization: Science Applications International Corporation
1321 Research Park Drive
Dayton, OH 45432

Author: Bruce Esken, Paul Hannen, Lawrence Janning, John Langenderfer

Abstract: This document updates and supercedes JTCG/AS-92-SM-006, "Software User's Manual for ALARM91". It describes the input and output variables for the Advanced Low Altitude Radar Model (ALARM 3.0) program. This document contains the basic information needed to execute the ALARM 3.0 version of ALARM. Appendix B contains ALARM 3.0 output formats. Appendix C contains ALARM 3.0 sample inputs. Appendix D contains the corresponding output for the input files. The input files have been designed to test many aspects of ALARM 3.0 operation and may be used to verify proper operation of the model after installation. The output files contained in Appendix D contain only the resultant contour plot or flight path output, not the full echo of the input data. The full output files are included with the released software. Appendix E contains sample ALARM 3.0 run preparation instructions. Appendix F contains information of the support programs: GENANT, which generates basic antenna patterns; GRAPHIT, which generates flight path data plots: PDMERG, which merges multiple binary plot data files, PREPGP and PREPXP, which generate contour plots; and DIMENS, which changes frequently used parameters. Appendix G contains a change/error notification form for ALARM 3.0 to be returned to WL/AAWA-1 if problems are foumd to ideltify or to identify suggested future modifications.

This document was generated by Science Applications International Corporation under contract number F33615-89-C-1067, for the Electronic Warfare Requirements and Effectiveness Branch, Electronic Warfare Division of the Avionics Directorate at the Wright Laboratory (WL), Wright-Patterson AFB, OH. Additional work performed under the same contract number was performed to update ALARM and its documentation. Much of the effort during this task was in direct support of the Electronic Combat Simulation Research Laboratory.

SM-9-12 JTCG/AS-93-M-011 **UNCLASSIFIED**

Title: Software Programmers Manual for the Advanced Low ALtitude Radar Model (ALARM 3.0)

Issued: 16 August 93
DTIC AD #: Not Issued
Sponsor: Wright Laboratory
2241 Avionics Circle
WPAFB, OH 45433-7318
SURVIAC File #: Not Issued

Project Engineer: Robert Ehret (WL/AAWA-1)

Performing Organization: Science Applications International Corporation
1321 Research Park Drive
Dayton, OH 45432

Author: Bruce Esken, Paul Hannen, Lawrence Janning, John Langenderfer

Abstract: This document updates and supercedes JTCG/AS-92-SM-007, "Software Programmer's Manual for ALARM91". It describes ALARM 3.0 from the computer science perspective and is intended to be a guide to the structure and methodology of the model. First, this document identifies the software programming environment necessary for ALARM 3.0. This is followed by the programming information associated with the computer science implementation of ALARM .30. This information is organized in the same manner as the model's source code structure. Appendix A contains a flow tree of ALARM 3.0 and Appendix B contains a brief description of each module in the model. It is strongly suggested that the Operational Concepts Document/Analyst's Manual be read first to gain an understanding of ALARM 3.0 from an engineering perspective.

This document was generated by Science Applications International Corporation under contract number F33615-89-C-1067, for the Electronic Warfare Requirements and Effectiveness Branch, Electronic Warfare Division of the Avionics Directorate at the Wright Laboratory (WL), Wright-Patterson AFB, OH. Additional work performed under the same contract number was performed to update ALARM and its documentation. Much of the effort during this task was in direct support of the Electronic Combat Simulation Research Laboratory.

SM-9-12 JTCG/AS-93-M-010 **UNCLASSIFIED**

Title: Operational Concepts Document (Analyst's Manual) for the Advanced Low Altitude Radar Model (ALARM 3.0)

Issued: August 1993 **DTIC AD #:** Not Issued

Sponsor: Wright Laboratory **SURVIAC File #:** Not Issued
2241 Avionics Circle
WPAFB, OH 45433-7318

Project Engineer: Robert Ehret (WL/AAWA-1)

Performing Organization: Science Applications International Corporation
1321 Research Park Drive
Dayton, OH 45432

Author: Bruce Esken, Paul Hannen, Lawrence Janning, John Langenderfer

Abstract: This document updates and supercedes JTCG/AS-92-SM-008, "Analysts Manual for ALARM91". It is an Operational Concepts Document (Analyst's Manual) which describes the engineering implementation of the Advanced Low Altitude Radar Model (ALARM 3.0) program. It describes the engineering implementation of ALARM 3.0, addressing both pulsed, moving target indication (MTI), and pulse doppler radars. The engineering implementation of both external and internal signals are discussed. External signals are those associated with the target body, target rotor blade, jammer, and clutter. Internal signals are those associated with the system noise and signal-to-interference ratio (S/I). The engineering implementation of all signal processing in ALARM 3.0 is discussed. This discussion covers doppler filters, MTI system, and the clutter response of the doppler filters and MTI system. The engineering implementaiton of all radar support functions is discussed. These support functions include: atmospheric attenuation, MTI system gating, pattern propagation factor, pulse blanking and eclipsing, radar antenna gain, detection theory, target radar cross section (RCS), and clutter reflectivity for land and sea. Finally, the engineering implementation of the geometry and terrain simulation support functions is discussed. Where appropriate, the OCD/AM relates the theory to the implementaiton of the methodology in ALARM 3.0.

This document was generated by Science Applications International Corporation under contract number F33615-89-C-1067, for the Electronic Warfare Requirements and Effectiveness Branch, Electronic Warfare Division of the Avionics Directorate at the Wright Laboratory (WL), Wright-Patterson AFB, OH. Additional work performed under the same contract number was performed to update ALARM and its documentation. Much of the effort during this task was in direct support of the Electronic Combat Simulation Research Laboratory.

SM-7-07 JTCG/AS-93-SM-009 **UNCLASSIFIED**

Title: Software User's Manual - TRAP 3.1

Issued: March 1993 **DTIC AD #:** Not Issued

Sponsor: FASTC/TANW **SURVIAC File #:** 13849
4115 Hebble Creek Rd Suite 28
Wright Patterson AFB, OH 45433-5632

Project Engineer: Joe Herrmann

Performing Organization: Battelle
505 King Ave
Columbus, OH 43201-2693

Author: Timothy R. Byram, Donald G. Lewis, Douglas D. Perry, David J. Hoey (editor), Batelle, Columbus, OH

Abstract: This report documents the Trajectory Analysis Program (TRAP) computer code, version 3.1, User's Manual, and supercedes TRAP version 3.0.

SM-2-02 JTCG/AS-93-SM-009 **SECRET**
NSWCCD/RDTN-93/012

Title: The ESAMS 2.6 IRCM Flare Additions (U)

Issued: 30 September 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 14243

Project Engineer: John O. Bennett, Code 4072 Crane

Performing Organization: Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: James T. Sweeten, Jr.

Abstract: (U) This report provides information for users on the implementation of the MJU-7A/B, MJU-8A/B, MJU-10, MJU-22/B and M205 flares into ESAMS 2.6.

SM-2-02 JTCG/AS-93-SM-008 **SECRET**
NSWCCR/RDTN-93/009

Title: Gen-X Decoy Model in ESAMS 2.6 (U)

Issued: 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John O. Bennett

Performing Organization: Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: John O. Bennett

Abstract: (U) This report provides information for users, analysts, and programmers on the GEN-X expendable decoy model as integrated into ESAMS 2.6. This includes sample runs, discussion of input and output, discussion of model features, and a listing of all new and modified code necessary to implement the model in ESAMS 2.6. This document is not intended to stand alone. Rather, it must be used in conjunction with earlier documentation on the GEN-X model in ESAMS versions 1.5 and 1.7.

SM-2-02 JTCG/AS-93-SM-006 **SECRET**
NSWCCR/RDTN-93/006

Title: ESAMS 2.6 Analyst's and Programmer's Manual for the Projected Area Self Protection Chaff Model (U)

Issued: June 1993 **DTIC AD #:** Not Issued
Sponsor: Naval Surface Warfare Center, Crane Division **SURVIAC File #:** Not Issued
300 Highway 361
Crane, IN 47522-5001

Project Engineer: John O. Bennett, Code 4072 Crane

Performing Organization: ARC Professional Services Group
Information Systems Division

Author: James T. Sweeten, Jr.

Abstract: (U) This report provides information for programmers on the Crane Projected Area Chaff Cloud model as intergrated into ESAMS 2.6. This report is an addendum to the ESAMS 1.7 version showing changes made in transfering the model from ESAMS 1.7 to ESAMS 2.6.

SM-2-02 JTCG/AS-93-SM-005 **SECRET**
NSWCCR/RDTN-93/005

Title: ESAMS 2.6 Users Manual for the Projected Area Self Protection Chaff Model (U)

Issued: June 1993 **DTIC AD #:** Not Issued
Sponsor: Naval Surface Warfare Center, Crane Division **SURVIAC File #:** Not Issued
300 Highway 361
Crane, IN 47522-5001

Project Engineer: John O. Bennett, Code 4072 Crane

Performing Organization: ARC Professional Services Group
Information Systems Division

Author: James T. Sweeten, Jr.

Abstract: (U) This report provides information for users on the Crane Projected Area Chaff Cloud Model as integrated into ESAMS 2.6. This report is an addendum to the ESAMS 1.7 version showing changes made in transfering the model from ESAMS 1.7 to ESAMS 2.6.

SM-2-02 JTCG/AS-93-SM-004 **SECRET**
NSWCCR/RDTN-93/004

Title: Generic Towed Decoy Model in ESAMS 2.6 (U)

Issued: 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 14011

Project Engineer: John O. Bennett

Performing Organization: Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: John O. Bennett

Abstract: (U) This report provides information for users, analysts, and programmers on the generic towed decoy model as integrated into ESAMS 2.6. This includes sample runs, discussion of input and output, discussion of model features as well as limitations, discussion of methodology used in the model, and a listing of all new and modified code necessary to implement the model in ESAMS 2.6.

SM-3-06 JTCG/AS-93-SM-001 **UNCLASSIFIED**

Title: Software Requirements Specification for the IVIEW 2000 Project of the Combat Analysis Program Support (CAPS)

Issued: February 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: T. Andrews

Performing Organization: NAIC/TAAE
WPAFB, OH 45433

Author: T. Andrews

Abstract: This document describes the software requirements specifications for the IVIEW 2000 aerial engagement reconstruction tool. This software tool is used to replay aerial engagement history data in a three-dimensional space. The visualization graphics include aircraft and missile icons, map data, and graphing windows of user defined parameters.

SM-0-09 JTCG/AS-92-SM-031 **SECRET**
ASD-TR-91-5029

Title: Component Vulnerability (Pd/h) Workshop - Recommendations and Panel Summaries (U)

Issued: March 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13610

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division

Author: Cramer, Russell (Frontier Technology, Inc.); Bennett, Gerald (ASD/XRM)

Abstract: (U) One of the steps in the vulnerability assessment process of aeronautical systems to non-nuclear weapons is the development of estimates of the probability of damage given a hit (Pd/h) for the critical components. Recent assessments and reviews of overall documentation and supporting b allistic test data showed that no well-docuemnted body of data existed for use in current and future vulnerability analyses.

(U) In order to evaluate and document the current state-of-the-art and needed improvements and supporting ballistic test programs, a Component Vulnerability (Pd/h) Workshop was defined and convened in March 1991. Panels, composed of DoD and contractor experts, examined the current capabilities, recommended Pd/h data for current DoD usage, and developed suggested improvements and extension programs. This report summarizes the Workshop and each of the Panel reports.

SM-9-04 JTCG/AS-92-SM-030 **UNCLASIFIED**

Title: High Power Microwave (HPM) Vulnerability Assessment Guide

Issued: April 93 **DTIC AD #:** Not Issued
Sponsor: U.S. Army Research Laboratory (ARL) **SURVIAC File #:** 01936L
2800 Powder Mill Road
Adelphi, MD 20783-1197

Project Engineer: John Tatum AMSRL-WT-NF

Performing Organization: SPARTA, Inc.
4901 corporate Drive
Huntsville, AL 35805-6201

Author: R. E. O'Connor, R.O. Haack, H.O. Everitt

Abstract: High Power Radio Frequency Microwave (HPRF/M) radiation can cause adverse effects on the electronics of aeronautical systems. This guide has been developed to aid aeronautical survivability analysis in estimating the vulnerability of aircraft and missiles to HPM. The guide contains basic mathematical models for HPM coupling and component failure thresholds to aid the analyst in estimating both the aircraft failure level and the types of effects. Using this guide, the survivability analyst can make quick, initial estimates of the power density required to cause aircraft failure due to HPM induced interference/upset and/or damage to the aircraft's electronic system. Based on these required HPM power density levels, the safe keep-out range of an aircraft from a specific HPM emitter can be determined.

SM-2-02 JTCG/AS-92-SM-029 **SECRET**
NSWCCR/RDTN-92/0016

Title: The ESAMS 1.7 Programmer's Manual for the Projected Area Self Protection Chaff Model (U)

Issued: 26 August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13791

Project Engineer: James T. Sweeten, Jr.

Performing Organization: Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: James T. Sweeten, Jr.

Abstract: (U) This report provides information for programmers on the projected area self protection chaff model in ESAMS 1.7. See also The ESAMS 1.7 Analysts Manual for the Projected area Self Protection Chaff Model NSWCCR/RDTN-92/0015 and The ESAMS 1.7 Users Manual for the Projected Area Self Protection Chaff Model NSWCCR/RDTN-92/0014.

SM-2-02 JTCG/AS-92-SM-028 **SECRET**
NSWCCR/RDTN-92/0015

Title: The ESAMS 1.7 Analyst Manual for the Projected Area Self Protection Chaff Model (U)

Issued: 26 August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13790

Project Engineer: James T. Sweeten, Jr.

Performing Organization: Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: James T. Sweeten, Jr.

Abstract: (U) This report provides information for analysts on the projected area self protection chaff model in ESAMS 1.7. See also The ESAMS 1.7 Users Manual for the Projected Area Self Protection Chaff Model NSWCCR/RDTN-92/0014 and The ESAMS 1.7 Programmers Manual for the Projected area Self Protection Chaff Model NSWCCR/RDTN-92/0016

SM-2-02 JTCG/AS-92-SM-027 **SECRET**
NSWCCR/RDTN-92/0014

Title: The ESAMS 1.7 User's Manual for the Projected Area Self Protection Chaff Model (U)

Issued: 26 August 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13789

Project Engineer: James T. Sweeten, Jr.

Performing Organization: Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: James T. Sweeten, Jr.

Abstract: (U) This report provides information for users on the projected area self protection chaff model in ESAMS 1.7. See also The ESAMS 1.7 Analysts Manual for the Projected Area Self Protection Chaff Model NSWCCR/RDTN-92/0015 and The ESAMS 1.7 Programmers Manual for the Projected area Self Protection Chaff Model NSWCCR/RDTN-92/0016

SM-2-02 **JTCG/AS-92-SM-026** **SECRET**
NSWCCR/RDTN-92/0013

Title: Generic Towed Decoy Model in ESAMS 1.7 (U)

Issued: May 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John O. Bennett

Performing Organization: Naval Surface Warfare Center Crane Division
300 Highway 361
Crane, IN 47522-5001

Author: John O. Bennett, Charles Hantzis (Atlantic Research Corp.), Lyman Hitchcock (Editor)

Abstract: (U) This report provides information for users, analysts, and programmers on the generic towed decoy model as integrated into ESAMS 1.7. This includes sample runs, discussion of input and output, discussion of model features as well as limitations, discussion of methodology used in the model, and a listing of all new and modified code necessary to implement the model in ESAMS 1.7. Volume I contains the user, analyst and programmer manuals. Volume 2 contains the code listing.

SM-8-13 **JTCG/AS-92-SM-025** **UNCLASSIFIED**
ARL-CR-69

Title: A Guide to FASTGEN Target Geometric Modeling

Issued: October 1993 **DTIC AD #:** Not Issued
Sponsor: U. S. Army Research Laboratory **SURVIAC File #:** Not Issued
AMSRL-OP-CI-B
Aberdeen Proving Ground, MD 21005-5066

Project Engineer: Dr. Abdul R. Kiwan

Performing Organization: ASI Systems International
838 N. Elgin Pkwy, Suite 421
Fort Walton Beach, FL 32548

Author: Edward D. Aitken, Susan L. Jones, and Allen W. Dean

Abstract: Vulnerability analysis programs, such as COVART, require target description data of sufficient detail and completeness to represent the physical and geometric detail of the target model from any attack aspect. The FASTGEN 3 computer model is used to generate the target description by developing a listing of the physical dimensions of target components, component location, and air spaces encountered along parallel shotlines passing through the target from a specified attack direction.

A prerequisite to the execution of FASTGEN is the development of a geometric description of a target whose exterior and interior components surfaces are described using triangles, spheres, cones, cylinders, and rods. the objective of this manual is to provide a gujide to experienced and inexperienced model developers to assist them in developing geometric models using the CONVERT computer code to generate target description data in the FASTGEN fdormat. Specific model preparation procedures, recommended procedures, frequently encountered pitfalls and proven shortcut model preparation procedures are discussed. Emphasis is placed on the use of CONVERT constructs in model development.

SMART JTCG/AS-92-SM-019 **UNCLASSIFIED**

Title: Annotated Briefing for the SMART Project Proof of Concept

Issued: July 1992 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Dave Hall

Performing Organization: Naval Air Warfare Center
Weapons Division, Code C21806
China Lake, CA 93555

Author: Hall, David; Muessig, Dr. Paul

Abstract: This annotated briefing is an Unclassified version of a Secret briefing delivered to the Susceptibility Model Assessment and Range Test (SMART) Project Senior Steering Group (SSG) on 16 July 1992. SMART's goal is to develop, test, establish and transition a verification, validation and configuration management process for mature models and simulaitons (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

The briefing summarizes the results of a Proof of Concept for the SMART Project, wherein the actual implementation of essential project functions was presented, with examples of associated deliverables that would support M&S accreditation.

SMART JTCG/AS-92-SM-018 **UNCLASSIFIED**

Title: The Adequacy of Field Test Data to Support Model Validation

Issued: July 1992 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 14136

Project Engineer: Dave Hall

Performing Organization: Arrowhead Technologies, Inc.

Author: Simecka, Karl

Abstract: This report focuses on one of the basic questions asked regarding the validation of aircraft survivability models and simulations: are field test data of sufficient accuracy to support comparisons with model outputs? This study was conducted to provide a quantitative answer to the question. The developers of the Enhanced Surface-to-Air Missile Simulation (ESAMS) and the Advanced Low Altitude Radar Model (ALARM) were asked to determine the accureacies and sampling rates they would desire for validation of their models. A limited set of this information was compared against field instrumentation capabilities found in the data base called Automated Range Resources Inventory Planning System (ARRIIPS), compiled by the Air Force Operational Test and Evaluation Center (AFOTEC). the report summarizes the comparison between range capabilities as specified in ARRIIPS and the data requirements specified by the model developers.

This effort was conducted under the auspices of the Susceptibility Model Assessment and Range Test (SMART) Project, whose goal is to develop, test, establish and transition a verification, validation and configuration management process for mature models and simulaitons (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

SMART JTCG/AS-92-SM-017 — UNCLASSIFIED

Title: RADGUNS Sensitivity Analysis Report

Issued: June 1993 — **DTIC AD #:** Not Issued

Sponsor: JTCG/AS — **SURVIAC File #:** 14006

Project Engineer: Dave Hall

Performing Organization: ASI Systems International
825 N. Downs
Ridgecrest, CA 93555

Author: Humes, Tracy; O'Neal, Barry

Abstract: This report describes the results of a sensitivity analysis conducted on the functional elements (FEs) of the Radar Directed Gun System Simulation (RADGUNS), conducted under the auspices of the Susceptibility Model Assessment and Range Test (SMART) Project, whose goal is to develop, test, establish and transition a verification, validation and configuration management process for mature models and simulaitons (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

In the SMART validation process, a model is first broken down into a hierarchy of FEs, each of which contributes to the overall model result: prediction of radar detection performance in the case of ALARM. Part of the validation process includes a sensitivity analysis at the FE level, which tests each FE over and beyond its typical range of operation in order to uncover sensitivities to input data (and other) assumptions, and to help specify data collection requirements that would facilitate validation of the FE. This report describes the sensitivity analysis process and the results that were obtained for RADGUNS.

SMART JTCG/AS-92-SM-016 — UNCLASSIFIED

Title: ALARM Sensitivity Analysis Report

Issued: November 1992 — **DTIC AD #:** Not Issued

Sponsor: JTCG/AS — **SURVIAC File #:** 14007

Project Engineer: Dave Hall

Performing Organization: SAIC
2301 Yale Blvd, SE, Suite E
Albuquerque, NM 87106

Author: Goodman, Thomas; Landis, David; von Loh, John; Wixson, Edwin

Abstract: This report describes the results of a sensitivity analysis conducted on the functional elements (FEs) of the Advanced Low Altitude Radar Model (ALARM), conducted under the auspices of the Susceptibility Model Assessment and Range Test (SMART) Project, whose goal is to develop, test, establish and transition a verification, validation and configuration management process for mature models and simulaitons (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

In the SMART validation process, a model is first broken down into a hierarchy of FEs, each of which contributes to the overall model result: prediction of radar detection performance in the case of ALARM. Part of the validation process includes a sensitivity analysis at the FE level, which tests each FE over and beyond its typical range of operation in order to uncover sensitivities to input data (and other) assumptions, and to help specify data collection requirements that would facilitate validation of the FE. This report describes the sensitivity analysis process and the results that were obtained for ALARM.

SMART **JTCG/AS-92-SM-015** **UNCLASSIFIED**
ENTEK/ABQ-93-0104-TR

Title: VV&A/CM Status Report for ESAMS, ALARM, and RADGUNS

Issued: April 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 14015

Project Engineer: Dave Hall

Performing Organization: ENTEK, INc.
2201 Buena Vista S.E., Suite 301
Albuquerque, NM 87106

Author: Ellis, Dr. Sharon; Krenz, Timothy

Abstract: This report describes the Verification, Validation, Accreditation and Configuration Management (VV&A/CM) status and activities discovered for the Enhanced Surface-to-Air Missile Simulation (ESAMS) Version 2.6.2, the Advanced Low Altitude Radar Model (ALARM) 1991 release, and the Radar Directed Gun System Simulation (RADGUNS) Version 1.7. The purpose of the document is to identify and summarize previous verification and validation activities, prior accreditations, and configuration management activities for each of these models. This establishes a baseline set of VV&A/CM information that can (and has been) used to tailor future V&V and CM activities for these models.

This effort was conducted under the auspices of the Susceptibility Model Assessment and Range Test (SMART) Project, whose goal is to develop, test, establish and transition a verification, validation and configuration management process for mature modes and simulaitons (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

As the SMART Project becomes cognizant of other V&V activities, and as it pursues its own V&V program, this document will be updated and revised to reflect such results, and VV&A/CM Status Reports for each individual model will be developed.

SMART **JTCG/AS-92-SM-014** **UNCLASSIFIED**
JTCG/AS-92-SM-FEAR

Title: ALARM Functional Element Assessment Report

Issued: March 1993 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 14008

Project Engineer: Dave Hall

Performing Organization: SAIC
2301 Yale Blvd, SE, Suite E
Albuquerque, NM 87106

Author: Goodman, Thomas; Landis, David; von Loh, John; Wixson, Edwin

Abstract: This document summarizes the current status of validation efforts for the Advanced Low Altitude Radar Model (ALARM), conducted under the auspices of the Susceptibility Model Assessment and Range Test (SMART) Project. SMART's goal is to develop, test, establish and transition a verification, validation and configuration management process for mature models and simulations (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

For this report, test data from a variety of sources were collected and compared to model predictions for the conditions of the test. The document describes the process used and the results of the comparisons in accordance with a standard reporting format developed by the SMART Project for this purpose. The report includes: 1) a description of each major functional element (FE) and how it is implemented in ALARM; 2) a sessitivity analysis plan, describing how each FE was tested over and beyond its range of operation to determine sensitivity to input data (and other) assumptions; 3) sessitivity analysis results; 4) a description of the data required to validate the FE, including required accuracies and sampling rates to ensure valid statistical comparisons with measured test data; 5) a description of the actual data collected; 6) an FE assessment plan, describing how the data were used to validate the FE, and; 7) FE assessment results and conclusions. These reports are updated regularly by the SMART Project as new test data become available.

SMART **JTCG/AS-92-SM-013** **SECRET**
BDM/A-92-1189-S

Title: ESAMS Functional Element Assessment Report for the SMART Project Proof of Concept (U)

Issued: July 1992 **DTIC AD #:** Not Issued
Sponsor: Naval Air Warfare Center Weapons Division **SURVIAC File #:** Not Issued

Project Engineer: Dr. Paul Muessig

Performing Organization: BDM International, Inc.
1801 Randolph Rd. SE
Albuquerque, NM 87106

Author: Not reported in Document

Abstract: Report Documentation Page (Standard Form 298) was not included in this document. The following was derived from the Executive Summary.

(U) For the Proof of Concept (POC), the RF Sensors and countermeasures functions of ESAMS were decomposed into 20 functional elements. Five elements were chosen to demonstrate the functional element assessment process with actual test data. The chosen elements were: (1) Automatic Gain Control (AGC), (2) Antenna Gain, (3) Moving Target Indicator (MTI), (4) Angle Track, (5) Range Track.

(U) The Functional Element Assessment Report (FEAR) consists of a number of sections that parallel the activities described above. These sections are: (1) Functional Element Description, (2) Sensitivity Analyses, (3) Data Requirements Dictionary, (4) Functional Element Assessment Plan, (5) Functional Element Assessment Results. Each of the five functional element assessments in this report contains the five sections described above. This format comprises the paradigm for functional element assessments used by the SMART Project. A similar paradigm for overall model assessment reports (MARS) will be developed as more data at the functional element level for each model become available.

SMART JTCG/AS-92-SM-012 SECRET
BDM/ABQ-92-0058-TR-R1

Title: Functional Element Decomposition and Data Requirements Dictionary for the SMART Project (U)

Issued: July 1992 **DTIC AD #:** Not Issued
Sponsor: Naval Air Warfare Center Weapons Division **SURVIAC File #:** Not Issued

Project Engineer: Dr. Paul Muessig

Performing Organization: BDM International, Inc.
1801 Randolph Rd. SE
Albuquerque, NM 87106

Author: Dr. R. Sam Baty and Ms Vandi Williams (BDM International, Inc.) and Mr. Ed Wixson (The SURVICE Engineering Co.)

Abstract: Report Documentation Page (Standard Form 298) was not included in this document. The following was derived from the Introduction.

(U) This document provides the requirements for experimental data thought necessary to assess the ALARM91 and ESAMS 2.6.2 models. The document has been prepared following the SMART program concepts and procedures for model assessment. It consists of three components:

- Functional Template,
- Data Requirements Dictionary,
- Functional Element Descriptions.

Both the Missile Flyout and RF Sensor sections contain all three components.

(U) The Functional Template decomposes the models into generic, identifiable functional elements which match those of the real world missile system, targets, and environment. Like a table of contents, it maps the contents of the two sections following it. The Data Requirements Dictionary lists those experimental data required to validate each functional element identified by the Functional Template. This is the heart of the SMART assessment process, which espouses the concept of overall model validation through the validation of each functional element. Finally, the Functional Element Descriptions identify how each specific model implements each of the generic functions and provides insights in testing requirements and measured vs. modeled performance comparisons. The document has merged the templates, data requirements, and functional descriptions for both the ALARM91 and ESAMS 2.6.2 models to demonstrate that the functions and data requirements are not unique, supporting the SMART concept that common data can be used to validate classes of models.

SMART JTCG/AS-92-SM-011 **UNCLASSIFIED**
ENTEK/AS-92-0115-TR

Title: Software Verification Requirements Study for the SMART Project

Issued: June 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 14137

Project Engineer: Dave Hall

Performing Organization: ENTEK, Inc.
2201 Buena Vista, S.E., Suite 301
Albuquerque, NM 87106

Author: Ellis, Dr. Sharon; Krenz, Timothy

Abstract: The purpose of this Software Verification Requirements Study (SVRS) is to define software verification requirements for mature M&S. The work was conducted under the auspices of the Susceptibility Model Assessment and Range Test (SMART) Project. SMART's goal is to develop, test establish and transition a verification, validation and configuration management process for mature models and simulations (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S. The report reviews and summarizes MIL-STD, DoD-STD and service-specific guidelines for software verification and analyzes them for application to mature M&S (those developed before promulgation of the standards). The report concludes with recommendations as to a minimum set of documentation required to support the verification of mature M&S software. Specific models in the target group of M&S included the Enhanced Surface-to-Air Missile Simulation (ESAMS), the Advanced Low Altitude Radar Model (ALARM) and the Radar-Directed Gun System Simulation (RADGUNS).

SMART JTCG/AS-92-SM-010 **UNCLASSIFIED**

Title: T & E Assets Database Assessment for the SMART Project

Issued: December 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 14135

Project Engineer: Dave Hall

Performing Organization: ASI Systems International
825 N. Downs
Ridegecrest, CA 93555

Author: O'Neal, Barry W.

Abstract: This document describes capabilities and features of database products and services that could support test planning and data collection efforts of the Susceptibility Model Assessment and Range Test (SMART) Project. SMART'S goal is to develop, test, establish and transition a verification, validation and configuration management process for mature models and simulations (M&S) that can be used to facilitate their accreditation in support of system acquisition (and other) decisions across the DoD and the Services. The current focus is on aircraft survivability M&S.

Examination of existing databases was aimed at the identification of specific test assets that might be employed in the service of model and simulation (M&S) validation, and the level of detail that could be ascertained regarding their data collection capabilities and/or limitations. Two databases were identified initially: the Test and Evaluation Long Range Investment Plant (TELRIP) package for the Navy Major Range and Test Facilities Base (MRTFB), and the DoD T&E Assets database, which is maintained on the TECNET system by the naval Air Test Center (NATC). A third product, the Air Force Systems Command (AFSC) Program Manager's Guide and Directory to Test Centers of Expertise, was found on the TECNET and included due to the applicability to SMART project planning efforts.

SM-6-01 JTCG/AS-92-SM-005 **SECRET**
NSWCCR/RDTN-91/OOO1 Part 1

Title: Users, Analyst & Programmers Manual for the Extension of the GEN-X Model ESAMS v1.5 - Part 1 (U)

Issued: January 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Sheila A. Markham

Performing Organization: NSWC-Crane
Crane, IN 47522-5001

Author: Sheila A. Markham

Abstract: (U) This report documents the extension of the GEN-X model to an additional missile system in ESAMS 1.5

SM-6-01 JTCG/AS-92-SM-005 **SECRET**
NSWCCR/RDTN-91/OOO1 Part 2

Title: Users, Analyst & Programmers Manual for the Extension of the GEN-X Model ESAMS v1.5 - Part 2 (U)

Issued: March 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John O. Bennett

Performing Organization: NSWC-Crane
Crane, IN 47522-5001

Author: John O. Bennett, Sheila A. Markham

Abstract: This report documents the extension of the GEN-X model to an additional missile system in ESAMS 1.5

SM-8-04F JTCG/AS-92-SM-004 **UNCLASSIFIED**
WL-TR-91-3017

Title: Reaction of AN/ALE-40 Flare Dispensers to Ballistic Impact

Issued: March 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13508

Project Engineer: Gerald Bennett

Performing Organization: WL/FIVS
WPAFB, OH 45433

Author: Lee, Lt Kurt; Bennett, Gerald

Abstract: The JTCG/AS Flares Test Program, conducted at the Aircraft Survivability Research Facility (ASRF) at Wright-Patterson AFB, OH during August of 1991, was designed to investigate the reaction of the AN/ALE-40 flare dispenser to the impact of foreign threat munitions. Nine test shots, using an array of actual foreign munitions (7.62-mm Armor Piercing to 23-mm High Explosive), were taken on five AN/ALE-40 flare dispensers and four simulated dispensers fully loaded with a magazine of fifteen MJU-7A/B flares. the dispensers were contained inside of a test set-up that simulated the volume, configuration, and material that would be typical of an aircraft dry bay containing an AN/ALE-40 system. Temperature and pressure history inside of the test set-up was recorded to provide insight into possible damage from a impacted dispenser. The results of this program indicate a high probability of flare ignition on threat impact and a definite possibility for enhanced aircraft damage. Recommendations from the program include a careful consideration of flare dispenser location within aircraft and appropriate fire protection in dry bays where catastrophic damage from the impact of the flare dispenser is likely.

SM-6-01 **JTCG/AS-92-SM-002** **SECRET**
NWSC/CR/RDTN-316

Title: ECM Corrections in ESAMS v1.7 for SURVIAC Error Logs 044, 049, 058, 059, 061, 063, 064, and 0193 (U)

Issued: January 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John O. Bennett

Performing Organization: NWSC Crane Division
Crane, IN 49522-5001

Author: John O. Bennett

Abstract: This report documents the evaluation of the subject electronic countermeasures (ECM) error logs and the implementation of the necessary corrections in the Enhanced Surface-to-Air Missile Simulation (ESAMS) version 1.7

SM-9-03 **JTCG/AS-92-SM-001** **UNCLASSIFIED**
ASD-TR-91-5032

Title: A Summary of Aerospace Vehicle Computerized Geometric Descriptions for Vulnerability Analyses

Issued: May 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13426

Project Engineer: Gerald Bennett

Performing Organization: ASD/XRM

Author: Crosthwaite, Kevin R. (Booz•Allen & Hamilton, Inc.), Bennett, Gerald B. (ASD/XRM)

Abstract: This report represents the results of an update of a 1987 survey and summary of computerized geometric models of aeronautical systems being developed by the DoD for use in vulnerability analyses. These geometric representations are developed using the tri-Service documented MAGIC, SHOTGEN, FASTGEN3, GIFT, or SCAN computer programs. In addition, this edition also contains listings of aircraft analyzed using the JTCG/ME developed QRV computer program. A brief summary of each geometric model is presented and a DoD contact point for more information is identified. Models that have been placed in the Survivability/Vulnerability Information Analysis Center (SURVIAC) for distribution are also identified. The report is printed in a loose leaf format to permit future revisions by a page update procedure. A blank summary page is included in the report for use in submitting updates or additions to the summaries. This report replaces ASD-TR-87-5031. A complementary summary of computerized geometric models for ground targets has been generated by the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME). This report should be consulted for these types of targets.

SM-1-02 DC-FR-8015.302-1 **UNCLASSIFIED**

Title: Assessment of RF Effects on Systems (ARES): The Physical and Mathematical Foundations and User Manuals

Issued: August 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Capt David A. Knight, WL/TALP

Performing Organization: Kaman Sciences

Author: Yang, F. C.; Wong, F; Wong, I.; Lee, K.S.H.; Knight, D.; and Meinhart, R.

Abstract: This report is the revision of DC-FR-8013.301-1 and DC-M-8013-301-3, which briefly describes the ARES (Assessment of RF Effects on Systems) computer code and the mathematical/ physical bases on which it is built. ARES is designed to be an end-to-end tool for assessment. It consists of a data preparation module, coupling topology and calculation modules, a fault tree module, an event tree module, an output module, and a probability-of-effect (Pe) module, including a fragility subroutine. It utilizes simple coupling rules for the calculation of both narrowband and broadband coupling responses to reduce computational time while maintaining numerical accuracy. The program is in modular format which allows for easy improvements and modifications in the future.

SM-6-01 JTCG/AS-91-SM-011 **UNCLASSIFIED**
NWSC/CR/RDTN-304

Title: Description of the Time/Range-to-Go Feature on ESAMS 1.7

Issued: July 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John O. Bennett

Performing Organization: Naval Weapons Support Center
Crane, IN 97522-5001

Author: John Byerly, John O. Bennett

Abstract: This document describes the addition of time-to-go and range-to-go options to ESAMS 1.7. These options allow the starting time for ECM to be based on time-to-go before missile impact or missile to target range.

SM-1-07 JTCG/AS-91-SM-010 **UNCLASSIFIED**

Title: M-on-N Susceptibility Assessment Verification, Validation and Implementation (SAVVI) - Final Report

Issued: June 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: David H. Hall and Paul R. Muessig, NWC

Performing Organization: Naval Weapons Center, China Lake, CA - Code 3181
ASI System International

Author: Barry O'Neal, ASI Systems International, David H. Hall and Paul R. Muessig, NWC

Abstract: Given a need for the improvement of aircraft susceptibility assessment models and methodology, an identification of methodology shortfalls and data sources to test and validate models was undertaken. Using existing computer simulations approved or under consideration by the JTCG/AS, a benchmark comparison with data from an M-on-N tactical training scenario was conducted. The evaluation compared the predicted versus actual numbers and types of encounters, as well as the predicted versus actual outcomes of those encounters. Limitations of the methodology that were applicable to the assessment process, as well as shortfalls in the collected training data, were noted during the analysis and were accounted for via assumptions in order to arrive at reasonable conclusions. The comparative results are presented in this report, and demonstrate that range data can be successfully applied to assess the credibility of both models and analytical methodology if proper care is taken in the analysis. In addition, the analysis can be used to identify potential problem areas for some simulations. The final benchmark statistics demonstrate a fair agreement between predictions from the JTCG/AS models and actual range observations, but they must be constrained by reasonable assumptions that cover current simulation and test range limitations.

SM-6-01 JTCG/AS-91-SM-009 **SECRET/NOFORN**
NWSC/CR/RDTN-300

Title: Transition of the GEN-X Model from ESAMS 1.5 to ESAMS 1.7 (U)

Issued: March 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: John O. Bennett

Performing Organization: Naval Weapons Support Center
Crane, IN 47522-5001

Author: John O. Bennett

Abstract: (U) This document contains information of the transition of the GEN-X model from ESAMS 1.5 to 1.7. The test runs used in the User's Manual, which were run in ESAMS 1.5, have been run again in ESAMS 1.7. the output of these test runs is expressed in the same format as in the User's Manual for the purpose of comparison. This document concludes with a discussion of the modifications which were part of the transition.

SM-3-17 JTCG/AS-91-SM-008 **SECRET**

Title: ROCOCO COLUMN Warhead Threat Performance Model (U)

Issued: February 1991 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 12612

Project Engineer: Louis Diaz

Performing Organization: Aeronautical Systems Division
Eglin AFB, FL

Author: Lillard Gilbert

Abstract: (U) The ROCOCO COLUMN Warhead Threat characterization program was conducted specifically to provide fragment weight, shape, material, weight frequency, velocity decay, initial velocity and spatial dispersion information in a simple data array that defines the warhead capability to generate an antiaircraft threat. The missile warhead threat data array was developed for use in evaluating the vulnerability of combat aircraft and flight vehicle protection concepts. The information contained in this report was generated from the analysis of the ROCOCO COLUMN warhead test data.

SM-3-17 JTCG/AS-91-SM-007 **CONFIDENTIAL**
MSD/EN-TR-90-155

Title: ROCHELLE SALT Warhead Threat Performance Model (U)

Issued: February 1991 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 12728

Project Engineer: Louis Diaz

Performing Organization: Aeronautical Systems Division
Eglin AFB, FL

Author: Lillard Gilbert

Abstract: (U) This report documents the results from the ROCHELLE SALT Missile Warhead Threat Characterization Program. The program includes the warhead design information, test, test data analysis and development of the fragment threat performance data array, and equivalent yield blast table. This report provides fragment weight, shape, material, velocity and spacial dispersion information in a simple data array that defines the ROCHELLE SALT warhead capability to generate an antiaircraft threat.

SM-3-17 JTCG/AS-91-SM-006 **SECRET**
MSD/EN-TR-90-156

Title: CEASAR TRUMPET Warhead Threat Performance Model (U)

Issued: February 1991 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 12729

Project Engineer: Louis Diaz

Performing Organization: Louis Diaz, Aeronautical Systems Division
Eglin AFB, FL

Author: Lillard Gilbert

Abstract: (U) This report documents the results from the CEASAR TRUMPET Missile Warhead Threat Characterization Program. The program includes the warhead design information, test, test data analysis and development of the fragment threat performance data array, and equivalent yield blast table. This report provides fragment weight, shape, material, velocity and spacial dispersion information in a simple data array that defines the CEASAR TRUMPET warhead capability to generate an antiaircraft threat.

JTCG/AS-91-SM-005 UNCLASSIFIED

Title: Comparison of Electronic Countermeasures Modeling Techniques Among JTCG/AS Computer Simulations

Issued: January 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** TR-91-007

Project Engineer: Gerald Bennett

Performing Organization: Air Force Electronic Combat Office
WPAFB, OH 45433

Author: Dennis L. Detamore, Booz, Allen & Hamilton, Inc.

Abstract: The purpose of this report is to document the comparison of the Electronic Countermeasures (ECM) modeling in selected engagement level computer simulations. The comparison reviews both the RF sensor algorithms that are affected by ECM and the ECM capabilities of the selected simulations. The simulations selected for the comparison are the Air-to-Air System Performance Evaluation Model (AASPEM 3.3), Advanced Low Altitude Radar Model (ALARM 88), Enhanced Surface-to-Air Missile Simulation (ESAMS 2.5), Integrated Missile and Radar Simulation (IMARS), Radar-Directed Gun System Simulation (RADGUNS 1.4), TAC BRAWLER 5.0, and the Trajectory Analysis Program (TRAP 3.1).

JTCG/AS-91-SM-004 UNCLASSIFIED

Title: Comparison of RF Sensor Modeling Among JTCG/AS Survivability Simulations

Issued: January 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 11915

Project Engineer: Gerald Bennett

Performing Organization: Air Force Electronic Combat Office
WPAFB, OH 45433

Author: Dennis L. Detamore, Booz, Allen & Hamilton, Inc.

Abstract: The selected simulations were compared to a set of standards generated for this evaluation. The standards were for sensor types, sensor subsystems, environmental factors, and sensor procedures. The sensor subsystems, environment factors, and sensor procedures were characterized using three levels of detail: analytic, dynamic, and emulative. The analytic level is a simple, mathematical representation. The dynamic level is a well defined functional representation. The emulative level is a precise, detailed representation.

JTCG/AS-91-SM-003 UNCLASSIFIED

Title: Terms of Reference Handbook for the Modeling and Simulation of Aircraft Survivability

Issued: May 1991 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** TR-90-003

Project Engineer: Gerald Bennett

Performing Organization: Air Force Electronic Combat Office
WPAFB, OH 45433

Author: Dennis L. Detamore, Booz, Allen & Hamilton, Inc.

Abstract: This document establishes standardized definitions for nonnuclear aircraft survivability modeling and simulation terms. These standard terms are established so that communication problems that have confronted government and industry agencies involved in aircraft survivability analyses can be resolved and eliminated.

SM-8-04F JTCG/AS-91-SM-002 **UNCLASSIFIED**
SURVICE-TR-90-068

Title: Integration of Vulnerability Analysis Requirements into Aircraft JLF Test Plans

Issued: December 1990 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 4018

Project Engineer: Michael R. Weisenbach, ASC

Performing Organization: Aeronautical Systems Center
Wright-Patterson AFB, OH 45433

Author: A. M. Pascal, W. S. Vikestad, J. W. Foulk, The SURVICE Engineering Co.
(Michael R. Weisenbach, ASC/XRM)

Abstract: This report presents the results of an assessment of future aircraft Joint Live Fire (JLF) test programs to determine their applicability to the development of Probability-of-Kill-given-a-hit (Pk/h) values. Based on this review, a number of recommendations are provided for test modifications and additional supplemental tests which, if implemented, should improve the ability to support generalized Pk/h development and validation.

SM-9-04 JTCG/AS-90-SM-004 **SECRET**

Title: Directed Microwave Energy Weapon Simulation - DMEWS Version-AS - Analyst's Guide (U)

Issued: March 1990 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 7105V

Project Engineer: Mike Vincent (AMXSY-CA)

Performing Organization: Army Material Systems Analysis Activity
Aberdeen PG, MD

Author: Mike Vincent (AMXSY-CS)

Abstract: (U) The Directed Microwave Energy Weapon Simulation - Aircraft Survivability Version (DMEWS-AS) models a one-on-one engagement of a ground or air target by a directed microwave energy weapon (DMEW). The DMEW is modeled at a level of detail appropriate for a system effectiveness analysis. DMEWS-AS contains functional models representing the output of the DMEW microwave generator and the distribution of DMEW radiation by the DMEW antenna. No other DMEW functions are represented in DMEWS-AS. The engagement dynamics of the DMEWS-AS model are simulated by a modified version of the AMSAA INCURSION model. Several INCURSION routines have been modified to take into account the special characteristics of a microwave weapon. Other code modules determine the atmospheric attenuation and the probability of damage to susceptible components on the target. DMEWS-AS is an upgrade to DMEWS code originally developed by SPARTA, Inc. for U.S. AMSAA and updated in the area of target effects modeling for Harry Diamond Laboratories. The present upgrade was developed in accordance with the recommendations of the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) and was also sponsored by the JTCG/AS.

SM-9-04 JTCG/AS-90-SM-003 **SECRET**

Title: Directed Microwave Energy Weapon Simulation - DMEWS Version-AS - Analyst's Guide (U)

Issued: March 1990 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Mike Vincent (AMXSY-CA)

Performing Organization: Army Material Systems Analysis Activity
Aberdeen PG, MD

Author: Mike Vincent (AMXSY-CS)

Abstract: (U) The Directed Microwave Energy Weapon Simulation - Aircraft Survivability Version (DMEWS-AS) models a one-on-one engagement of a ground or air target by a directed microwave energy weapon (DMEW). The DMEW is modeled at a level of detail appropriate for a system effectiveness analysis. DMEWS-AS contains functional models representing the output of the DMEW microwave generator and the distribution of DMEW radiation by the DMEW antenna. No other DMEW functions are represented in DMEWS-AS. The engagement dynamics of the DMEWS-AS model are simulated by a modified version of the AMSAA INCURSION model. Several INCURSION routines have been modified to take into account the special characteristics of a microwave weapon. Other code modules determine the atmospheric attenuation and the probability of damage to susceptible components on the target. DMEWS-AS is an upgrade to DMEWS code originally developed by SPARTA, Inc. for U.S. AMSAA and updated in the area of target effects modeling for Harry Diamond Laboratories. The present upgrade was developed in accordance with the recommendations of the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) and was also sponsored by the JTCG/AS.

SM-8-09 JTCG/AS-90-SM-002 **SECRET**

Title: Effects of Low Energy Lasers on Aircraft - Volume II. Database of LEL Effects on Aircraft Sensors (U)

Issued: February 1994 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Mike Vincent (AMXSY-CA)

Performing Organization: Army Material Systems Analysis Activity
Aberdeen PG, MD

Author: Mike Vincent (AMXSY-CS)

Abstract: (U) A continuing need exists to update the available susceptibility data base as derived from system test results and from computer model predictions based on device parameters and component test results. The susceptibility data base serves as a source of input data to analyze investigating the impact of LEL on aircraft operaitons. This document is Volume II of the Final Report of a task defined by the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS). The assigned task was to survey the existing data on effects of low energy lasers on aircraft bio-optics effects and Volume I deals with the effects on EO sensors. Section 1 is the introduction; section 2 cites the types of lasers likely to be encountered in the threat; section 3 discusses types of equipment present in aircraft; section 4 discusses types and levels of damage; section 5 summarizes a number of reports reviewed in this field; section 6 attempts to summarize some of the data more compactly; and, section 7 presents some conclusions and final remarks.

SM-8-09 JTCG/AS-90-SM-001 **SECRET**

Title: Effects of Low Energy Lasers on Aircraft - Volume I. Effects on Bio-Sensors (U)

Issued: February 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 01250L

Project Engineer: Mike Vincent (AMXSY-CA)

Performing Organization: Army Material Systems Analysis Activity
Aberdeen PG, MD

Author: Mike Vincent (AMXSY-CS)

Abstract: (U) Low energy laser (LEL) threats to aircraft sensors are emerging and the effect on aircraft survivability is a critical issue. Various test data have been developed in recent years, but there has been no coordinated effort to relate/correlate effects, thresholds, and test conditions. This lack of a comprehensive data base interferes with the important tsk of assessing threats s the efficient countermeasures (CMs) may be provided. It also precludes assessment of the capability of developing LEL weapon systems to counter threat aircraft. The purpose of this document is to provide information on aircraft bio-susceptibility to LELs. This is Volume I of a two volume set. Volume II provides information on aircraft EO susceptibility to LELs. It is intended that the information provided in these volumes be helpful to analysts and modelers of LEL effects on aircraft.

SM-6-02 NWC TM 6517 **UNCLASSIFIED**

Title: Microstrip Patch Linear Traveling Wave Antenna Analysis/Synthesis

Issued: July 1989 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Donald D. Paolino

Performing Organization: NWC (Renamed Naval Air Warfare Center, Weapons Division)
China Lake, CA 93555-6001

Author: Donald D. Paolino

Abstract: This report documents the theory and experimental results of an investigation of microstrip patch antennas for planar monopulse service. This was a study of a simple linear traveling-wave array with monopulse processing to acquire knowledge of some of the problems peculiar to these arrays. Several unexpected problems appeared during the experimental phase of this effort. Some fixes were found and documented here. Also included is a description of the single-patch analysis of radiation and scattering (RCS), along with an array-synthesis technique. Both of these yielded good experimental correlation. The appendixes provide computer program listings implementing these techniques and a brief description of their logic. This is an informal report of the Naval Weapons Center and is not a part of the permanent records of the Department of Defense.

SM-3-17 JTCG/AS-89-SM-002 **SECRET**
TR-89-126.

Title: GRAY ROCK Warhead Threat Performance Model (U)

Issued: September 1989 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 10770

Project Engineer: Louis Diaz

Performing Organization: Aeronautical Systems Division
Eglin AFB, FL

Author: Lillard E. Gilbert

Abstract: (U) The GRAY ROCK Warhead Threat characterization program was conducted specifically to provide fragment weight, shape, material, weight frequency, velocity decay, initial velocity and spatial dispersion information in a simple data array that defines the warhead capability to generate an antiaircraft threat. The missile warhead threat data array was developed for use in evaluating the vulnerability of combat aircraft and flight vehicle protection concepts. The information contained in this report was generated from the analysis of the GRAY ROCK warhead test data.

SM-6-02 JTCG/AS-89-SM-001 **UNCLASSIFIED**

Title: User's Manual for IRVING (Infrared/Visible Imaging - Numerically Generated)

Issued: September 1989 **DTIC AD #:** B137327L

Sponsor: JTCG/AS **SURVIAC File #:** 10936

Project Engineer: Dr. Thomas L. Barnett

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: Dr. Thomas L. Barnett

Abstract: The procedures for operating the series of programs comprising the IRVING (Infrared/Visible Imaging - Numerically Generated) target/background signature model are described in "IRVING Users' Manual." Input procedures are outlined for all the parameters involved in building the geometrical target model, building the background model, and describing the physical, radiative, and scenario properties. A companion document is "How IRVING Works."

SM-6-02 NWC TP 6837 **SECRET**

Title: RF Interactive Scattering Analysis System and its Validation (U)

Issued: September 1988 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Wang, Helen T. G.

Performing Organization: NWC (Renamed Naval Air Warfare Center, Weapons Division)
China Lake, CA 93555

Author: Wang, Helen T. G. and Clark, Timothy S.

Abstract: (U) This report documents the results of a study of the RF interactive scattering analysis system and its validation. The objective of this project is to build an RF interactive system that would efficiently use the best parts of several different radar cross section (RCS) codes and be able to interact between the RCS codes. The approach taken with this work is fourfold: (1) write a preprocessor program to make the modeling task efficient, (2) write an executor program to select the appropriate code to use in each aspect angle region and combine the output results of all of them, (3) validate the combined RCS code against measured results, and (4) display the RCS level of each component of the target based on a color code.

SM-8-04F WRDC-TR-89-3105 **UNCLASSIFIED**

Title: An Investigation of Missile Warhead Fragment Impacts into Aircraft Hydraulic Lines

Issued: July 1989 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 4089

Project Engineer: Capt. Hagop Jubilian, USAF

Performing Organization: Wright Research and Development Center
WPAFB, OH 45433

Author: Capt. Hagop Jubilian, USAF

Abstract: Survivability and lethality engineers have been investigating the effectiveness of air-to-air and surface-to-air missiles against enemy aircraft for years. A specific area of study has been the vulnerability of aircraft hydraulic systems to these threats. The test described in this report was designed to statistically compare the capability of different sized missile warhead fragments traveling at various velocities to induce fires in aircraft hydraulic systems. A simulated aircraft dry bay containing a single hydraulic line was impacted by a simulated missile warhead fragment, and the results analyzed. A test matrix of 120 shots was divided into 12 unique test conditions , thus creating a large quantity of tests with a limited number of variables. This produced data which could be statistically analyzed with a high degree of confidence. The 12 individual conditions were 2 different sized fragments, 30 and 110 grains, tested each at nominal impact velocities of 3000, 3600, 4200, 4800, 5400, and 6000 feet per second. MIL-H-83282 type hydraulic fluid was used. The results showed statistically significant differences between impact velocity and the probability of fire. In addition, other data showed the importance of proper test design to avoid obtaining inaccurate results which could be easily evaluated improperly. The results of this program will be used to increase both the missile lethality and hydraulic system vulnerability data bases.

SM-6-02 JTCG/AS-88-SM-003 **UNCLASSIFIED**

Title: How IRVING (Infrared/Visible Imaging - Numerically Generated) Works - Descriptions of Procedures, Algorithms, and Submodels in IRVING

Issued: September 1989 **DTIC AD #:** B136624
Sponsor: JTCG/AS **SURVIAC File #:** 10935

Project Engineer: T. L. Barnett

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: T. L. Barnett

Abstract: The mathematics and physics involved in the IRVING models and subprograms is described in "How IRVING Works." This is a companion document to "Users' Manual for IRVING," and is used primarily to better understand the procedures in depth. To complete a working set of IRVING, a user must obtain a personal computer executable copy of LOWTRAN 6.0 to modify the source code and recompile QuickBasic is needed, and to utilize the mouse compatible features a mouse and appropriate mouse driver is needed. A set of 7 floppy disks are filed with this report.

SM-3-17 JTCG/AS-88-SM-002 **SECRET**
AD/EN-TR-88-1001

Title: HAVE ACRE Warhead Threat Performance Data Array (U)

Issued: May 1988 **DTIC AD #:** C955781
Sponsor: JTCG/AS **SURVIAC File #:** 09513

Project Engineer: Louis Diaz

Performing Organization: Aeronautical Systems Division,
Eglin AFB, FL

Author: Lillard E. Gilbert

Abstract: (U) The HAVE ACRE Warhead Threat Characterization Program was conducted specifically to provide fragment weight, shape, material, weight frequency, velocity decay, initial velocity, and spatial dispersion information in a simple data array that defines the warhead capability to generate an antiaircraft threat. The missile warhead threat performance data array was developed for use in evaluating the vulnerability of combat aircraft and flight vehicle protection concepts. The information in this report was generated from the analysis of the HAVE ACRE Warhead test data.

SM-3-15 JTCG/AS-88-SM-001 **UNCLASSIFIED**
ASD-TR-87-5031

Title: A Summary of Aerospace Vehicle Computerized Geometric Descriptions for Vulnerability Assessments

Issued: May 1987 **DTIC AD #:** B120115
Sponsor: JTCG/AS **SURVIAC File #:** 8994

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: G. Bennett, ASD

Abstract: This report presents the results of an update of a 1982 survey and summary of computerized geometric models of aeronautical systems being developed by the DoD for use in vulnerability assessments. These geometric representations are developed using the tri-service documented MAGIC, SHOTGEN, FASTGEN III, GIFT, or SCAN computer programs. Summaries of existing models are grouped by US aircraft, helicopters, and satellites, US missiles and target drones, generic aircraft components, foreign aircraft and helicopters, foreign missiles and target drones, and SCAN target descriptions. A brief summary of each geometric model is presented and a DoD point of contact for obtaining it is identified. The report is printed in a loose leaf format to permit future revisions by a page update procedure.

SM-6-06 JTCG/AS-87-SM-008 **UNCLASSIFIED**
AFWAL-TR-88-3051

Title: ESAMS Computer Program - User's Manual

Issued: August 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** TR-88-002

Project Engineer: Kenneth Mumford

Performing Organization: SURVIAC

Author: Kevin Crosthwaite, AFWAL/FIES/SURVIAC

Abstract: ESAMS is a generic computer program which can be used to model surface-to-air missile systems. The model currently has the capability of assessing the probability of kill for several foreign missile systems against USAF aircraft. The model simulates the interaction between a single airborne target and a specified SAM missile fired from a designated location. The characteristics modeled include sensor lock-on and tracking parameters, missile flight dynamics (including aerodynamics and propulsion(, missile guidance and control, target vulnerability, and countermeasures.

SM-6-06 JTCG/AS-87-SM-007 **UNCLASSIFIED**
WRDC-TR-89-6008

Title: ESAMS Computer Program - Programmer's Manual

Issued: September 1989 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** TR-88-005

Project Engineer: Kenneth Mumford

Performing Organization: WL/TXAA
WPAFB, OH 45433

Author: Mumford, K., Crosthwaite, K., Hamilton, L., Egner, D., et al.

Abstract: ESAMS is a generic computer program which can be used to model surface-to-air missile systems. The model currently has the capability of assessing the probability of kill for several foreign missile systems against USAF aircraft. The model simulates the interaction between a single airborne target and a specified SAM missile fired from a designated location. The characteristics modeled include sensor lock-on and tracking parameters, missile flight dynamics (including aerodynamics and propulsion), missile guidance and control, target vulnerability, and countermeasures.

SM-6-06 JTCG/AS-87-SM-006 **SECRET**
AFWAL-TR-88-3087 & SURVIAC-TR-88-003

Title: ESAMS Computer Program - Analyst Manual, Missiles, Parts 1-12 (U)

Issued: July 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Kenneth Mumford

Performing Organization: SURVIAC

Author: R. S. Baty, B. L. Burel, D. J. Carlson, K. M. Mumford, K. R. Crosthwaite, L. A. Hamilton, et. al.

Abstract: (U) ESAMS is a generic computer program which can be used to model surface-to-air missile systems. The model currently has the capability of assessing the probability of kill for the Soviet SA-2 through SA-14 missile systems against air vehicles. The model simulates the interaction between a single airborne target and a specified SAM missile fired from a designated location. The characteristics modeled include sensor lock-on and tracking parameters, missile flight dynamics (including aerodynamics and propulsion), missile guidance and control, target vulnerability , and countermeasures. Specific missiles are modeled in Parts 2 through 12 as follows: Part 2 - SA-2; Part 3 - SA-3; Part 4 - SA-4; Part 5 - SA-5; Part 6 - SA-6; Part 7 - SA-7 and SA-14; Part 8 - SA-8; Part 9 - SA-9 and SA-13; Part 10 - SA-10; Part 11 - SA-11; Part 12 - SA-12.

SM-6-06 JTCG/AS-87-SM-005 **UNCLASSIFIED**
AFWAL-TR-88-3051

Title: Enhanced Surface-to-Air Missile Simulation (ESAMS) Computer Program - Analyst Manual, Basic Methodology

Issued: August 1988 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** TR-88-002

Project Engineer: Kenneth Mumford

Performing Organization: SURVIAC

Author: Kevin Crosthwaite, AFWAL/FIES/SURVIAC

Abstract: ESAMS is a generic computer program which can be used to model surface-to-air missile systems. The model currently has the capability of assessing the probability of kill for several foreign missile systems against USAF aircraft. The model simulates the interaction between a single airborne target and a specified SAM missile fired from a designated location. The characteristics modeled include sensor lock-on and tracking parameters, missile flight dynamics (including aerodynamics and propulsion(, missile guidance and control, target vulnerability, and countermeasures.

SM-6-08 JTCG/AS-87-SM-004 **UNCLASSIFIED**

Title: Vulnerability of Shielded Piping for Aircraft Engines

Issued: April 1988 **DTIC AD #:** B124491
Sponsor: JTCG/AS **SURVIAC File #:** 09563

Project Engineer: Philip Niebuhr

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: Philip Niebuhr

Abstract: The testing reported here was prompted by the survivability enhancements being incorporated into the V-22 Osprey's T406-AD-400 engine. The VSTOL tiltrotor V-22 contains two T406 turboshaft engines being developed by the Allison Division of General Motors. One T406 engine can provide enough power to sustain conventional flight. Thus the disabling of one engine, short of dislodging the engine from the aircraft, does not constitute a KK-kill (catastrophic failure of the aircraft). Because of this redundancy, the probability of a KK-kill due to the loss of an oil or fuel line by a ballistic threat is very low. However, the loss of an oil or fuel line does result in a high probability of a B-kill (mission abort). If the survivability of these lines can be enhanced without a significant weight penalty, the aircraft's mission survivability can be increased greatly.

SM-6-02 JTCG/AS-87-SM-001 **SECRET**

Title: RCS Codes Analysis and Comparison (U)

Issued: March 1987 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Harold A. Brooks

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: T. G. Helen Wang (NWC Code 3313); Harold A. Brooks (Code 33812)

Abstract: The far-field RCS of a target is independent on the range but dependent on the shape and material composition of the target as well as the polarization, frequency and aspect angle of the incident wave.

This report documents the results of modeling studies done on a cylinder, a plate, a cube and a missile, using four different RCS computer codes. The results from different RCS computer codes are analyzed and compared to evaluate the RCS codes.

SM-3-13 JTCG/AS-86-SM-002 **UNCLASSIFIED**
NWSC/CR/RDTN - 258

Title: NSAMS Surface-to-Air Missile Simulation Users Manual (NWSC/CR/RDTR-258)

Issued: September 1986 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: J. Cabot Faultless

Performing Organization: Naval Weapons Support Center
Crane, IN 47522-5001

Author: William W. Newton, and J. Cabot Faultless

Abstract: This manual provides information required to successfully use the NSAMS Surface-to-Air Missile Simulation. Included is an overview of the simulation structure, input data requirements and formats, descriptions of running time options, descriptions of output options, and a trouble shooting guide. NSAMS is an adaptation of the ESAMS Simulations.

JTCG/AS-86-SM-001 **SECRET**
NWSC/CR/RDTR-301

Title: ESAMS Surface to Air Missile Simulation - ECM Applications Manual (U)

Issued: May 1986 **DTIC AD #:** C953863L
Sponsor: JTCG/AS **SURVIAC File #:** 07340

Project Engineer: L. C. Hitchcock

Performing Organization: Naval Weapons Support Center, Crane, IN

Author: L. C. Hitchcock

Abstract: (U) This is a User's Manual for the ECM options in the ESAMS Surface-to-Air Missile Simulations. It contains information necessary for the simulation user to effectively use the ECM options in the ESAMS programs.

JTCG/AS-85-SM-007 **UNCLASSIFIED**

Title: Laser Propagation Considerations for Modeling

Issued: June 1986 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** TR-86-002

Project Engineer: Gerald Bennett

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: Dr. V. Gail Hempley

Abstract: This paper only describes interactions that occur as a laser beam travels through the optical train of the laser system and then through the atmosphere. Each encountered phenomenon is described as conceptually and physically as possible. Most of the modeling descriptions in this paper have been taken from the Engagement simulation Model. This model evolved from the engineering development community. It appears to contain the most complete attempt to provide each phenomenon with a model. It is also widely accepted among the high energy laser development community although other methods of modeling each phenomenon have been indicated where they were known, there has been no attempt to provide a complete spectrum of models.

SM-5-04 JTCG/AS-85-SM-006 **UNCLASSIFIED**

Title: Survivability Methodology Requirements Definitions Study Summary and Results

Issued: December 1985 **DTIC AD #:** B111105

Sponsor: JTCG/AS **SURVIAC File #:** 08049

Project Engineer: Gerald Bennett

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: Dr. V. Gail Hempley

Abstract: The JTCG/AS has initiated a program to establish a suite of models that will provide analytical modeling required during the evaluation of tactical survivability issues. In this study, the basic requirements for this model structure are investigated. Section II describes these requirements and then relates them to the current state of the ASMR models. The other major part of this study was to examine the effectiveness of the methods of interfacing with the survivability community.

SM-3-29 JTCG/AS-85-SM-003 **SECRET (Vol III) UNCL (rem.)**
AFWAL-TR-85-3104

Title: Laser Threat Model Manuals — Vol I (Analyst's Manual), Vol II (User's Manual) (U), Volume III (Data Base Manual), Vol IV (Data Base Specifications Manual), Vol V (Programmer's Manual)

Issued: December 1985 **DTIC AD #:** B099005

Sponsor: JTCG/AS **SURVIAC File #:** 01223/4/5/6/7L&41L

Project Engineer: Gerald Bennett

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: Peggy Wagner, AFWAL

Abstract: The purpose of these manuals are to provide the programming user of the Laser Threat Model with the information necessary for the construction of the system files, tables, dictionaries, and directories.

SM-5-07 JTCG/AS-85-SM-001 **UNCLASSIFIED**

Title: Interface Between Missile Intelligence Agency Simulations and Naval Weapons Center Endgame Models

Issued: October 1985 **DTIC AD #:** B146091L

Sponsor: JTCG/AS **SURVIAC File #:** 07583

Project Engineer: Dorothy Saitz

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: Dorothy Saitz

Abstract: Missile Intelligence Agency (MIA) simulation data (Endgame Encounter Conditions) are available for input to the Naval Weapons Center endgame simulation MECA (Modular Endgame Computing Algorithms). This report documents the interface (method) between the MIA simulation and the NWC endgame models.

JTCG/AS-84-SM-003 UNCLASSIFIED
AFWAL TR-84-1020

Title: A Multi-path Clutter Model for Surface-to-Air Missile Simulations (SAMS) (AFWAL-TR-84-1020)

Issued: April 1984 **DTIC AD #:** B087307
Sponsor: JTCG/AS **SURVIAC File #:** 04088

Project Engineer: Gerald Bennett

Performing Organization: Avionics Laboratory (AFWAL/AAWA-1)
WPAFB, OH 45433

Author: M. West

Abstract: This report summarizes a study whose objective was to reformat the clutter multipath model used in the TAC ZINGER'S for inclusion in the top down SAMS. This study used the top-down code generated from the original program by another organization in conjunction with the original program in an attempt to provide a documented, structured Fortran implementation of the original model. In most instances, the original authors were able to provide code sections. The model is still limited to the same threats as the original track-while-scan model.

TA-3-03.0 JTCG/AS-84-T-001 UNCLASSIFIED
& TA-3-04.1 AFWAL TR-85-3028

Title: Soviet 30mm (155-A30) HEI Projectile Threat Performance Model

Issued: December 1984 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 05740

Project Engineer: L. E. Gilbert

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: L. E. Gilbert, T. Seymour

Abstract: The Soviet air-to-air 30-mm, 155 gunfired high explosive incendiary (HEI) projectile threat characterization program was conducted specifically to provide fragment decay, initial velocity, and spatial dispersion information in a simple model characterizing the threat. The threat model was developed for use in evaluating the vulnerability of USAF combat aircraft and flight vehicle protection concepts. The information contained in this report was generated in-house by the test, and reduction and analysis of data from three, 30-mm 155 HEI projectiles. The 30-mm program demonstrated the in-house capability of the flight vehicle protection branch to conduct gunfired HE projectile threat characterization test programs.

SM-3-11 JTCG/AS-82-SM-008 UNCLASSIFIED
NWC Tech Memo 4990

Title: Long-Range Air-to-Air Combat Methodology (LRAACM)

Issued: March 1983 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 11878

Project Engineer: Brad Kowalsky

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: Brad Kowalsky, NWC, Code 3381

Abstract: To establish a standardized methodology for the evaluation of long-range air-to-air combat, many existing methodologies were examined. That examination was fruitless, and it was decided to develop the architectures for eight air-to-air combat situations leading toward a comprehensive and specialized methodology for long-range air-to-air combat engagements. Those architectures are described in this report.

JTCG/AS-82-SM-005 **CONFIDENTIAL**
AFWAL-TR-83-3047

Title: Dynamic Warhead Fragment Threat Model Validation (U)

Issued: September 1983 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 3611

Project Engineer: L. E. Gilbert

Performing Organization: Wright Laboratories
WPAFB, OH 45433

Author: L. E. Gilbert

Abstract: This report contains the results of the validation of the dynamic warhead fragment threat model. The model was developed to provide accurate anti-aircraft missile warhead and gunfired projectile fragment threat information to the aircraft survivability and intelligence technical communities. The threat information provided by the model are fragment velocity and frequency per unit area at the aircraft interface.

JTCG/AS-82-SM-004 **UNCLASSIFIED**

Title: Summary of Aerospace Vehicle Computerized Geometric Description for Vulnerability Assessments

Issued: December 1982 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 1903

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: Gerald Bennett, ASD

Abstract: This report presents the results of an update of a 1975 survey and summary of computerized geometric models of aeronautical systems being developed by the Services for use in vulnerability assessments. The geometric representations are developed using the tri-service documented MAGIC, SHOTGEN, FASTGEN II, OR GIFT computer programs. Specialized geometric descriptions are also developed for the tri-service documented SCAN missile end-game simulation. The geometric models are grouped by domestic aircraft, helicopters and satellites, domestic missiles and target drones, foreign aircraft and helicopters, foreign missiles and target drones, aircraft components, and SCAN missile end-game models. Brief summaries of each of the target description efforts are presented and government points of contact are identified.

JTCG/AS-82-SM-003 **SECRET**
ASD XRM-TR-82-5027

Title: Vulnerability Predictors for Aircraft and Two Large Threat Weapons (U)

Issued: August 1982 **DTIC AD #:** C031220L
Sponsor: JTCG/AS **SURVIAC File #:** 02161

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: G. Bennett

Abstract: (U) Vulnerability Assessments of various U. S. Aircraft and helicopters to 57mm and SA-7 threats have been performed by government agencies and contractors in support of survivability assessments. This data base is collected, analyzed, and gaps in coverage are identified. Vulnerability assessments are performed on selected aircraft in these areas of weights and presented areas, and the results are used to increase the vulnerability data base. This data base is analyzed and, using regression analysis, equations are fitted to allow prediction of the aircraft presented areas as a function of the weights. Predictors are then developed using the extended data base for estimating the whole aircraft probability of kill as a function of the presented areas.

(U) Vulnerability predictors are developed for the two threats and three design groupings, single engine aircraft, twin-aircraft, and helicopters. For each of these groupings and threats, predictors are developed for each of the major views; top, bottom, front, rear, and side, as well as an average or mean value. The resulting equations provide predictors for estimating the vulnerabilities of conceptual aircraft and are recommended for use in the early design phase before the drawings and data needed to apply the more detailed and accurate assessment procedures are available.

JTCG/AS-82-SM-002 **UNCLASSIFIED**
ASD/XRM TR-82-5014

Title: Vulnerability Predictors for Tactical Aircraft and a Small Threat Weapon

Issued: August 1982 **DTIC AD #:** C030520L
Sponsor: JTCG/AS **SURVIAC File #:** 03457 & 07976

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: Gerald B. Bennett, J. P. Ryan

Abstract: Vulnerability predictor models to a small HE threat were generated for the primary aircraft "A" Kill subsystems in ASD-TR-80-5007. That study designated five primary "A" Kill subsystem contributors and generated unhardened predictors for each. In this study the data base and range of coverage is increased and three subsystem groupings are selected for revising predictors to account for hardening. The subsystems selected for modeling with hardening are the crew, wing fuel, and fuselage fuel. Predictors are developed for each subsystem for two or more hardening levels (including unhardened) for the six cardinal views and for the mean or average of the total aircraft.

The data base for the equation models consisted of actual vulnerability assessments of selected U.S. and foreign aircraft. Design information needed to apply the equations are fuel tank weights and sequencing, crew number, and arrangement. Two hardening levels were assigned for crew models (unhardened and hardened); whereas, the fuel tank models included three levels of hardening: unhardened, with internal tank protection, and with internal and external protection. The increased sample size also resulted in improved models for the unhardened condition. All hardened models were found to be functionally related to the same independent variable that was used for the unhardened models. These predictors were generated for preliminary design use and should be replaced by assessments using the normal techniques when drawings, background data and time become available. This is one of two parallel predictor development tasks for differing threat sizes and is the final report on the small HE threat task.

JTCG/AS-81-S-007 **CONFIDENTIAL**
NSWC TR 81-230

Title: Test Report of the Grill Heat I Warhead Arena (U)

Issued: August 1982 **DTIC AD #:** C029423L
Sponsor: JTCG/AS **SURVIAC File #:** 03117

Project Engineer: Jamison, M. R.

Performing Organization: Naval Surface Warfare Center
Dahlgren, VA

Author: Jamison, M. R.

Abstract: (U) This report provides the results of an arena firing of the GRILL HEAT I warhead. Fragmentation mass, spatial distribution, and velocity profile information were taken in the main beam spray. A large number of armor systems were placed at varying distances around the warhead in the densest portion of the fragmentation pattern.

SA-0-01 JTCG/AS-81-S-005 **UNCLASSIFIED**

Title: Benchmark for the ASALT Program; Assessment of Survivability Against Laser Threats

Issued: September 1981 **DTIC AD #:** A128473
Sponsor: Naval Weapons Center **SURVIAC File #:** 00223
China Lake, CA 93555

Project Engineer: David Hall

Performing Organization: ASI Systems International

Author: Fred J. Steenrod, John E. Musch

Abstract: The benchmark run of the ASALT computer program using data for an F-18 aircraft target is documented in this report. Also, described in this report, are several other computer programs that are useful in assembling data for input and output files from the benchmark process are included, so that the report serves as an example of the execution of the ASALT program and the programs which precede it.

SA-0-01 JTCG/AS-81-S-004 **UNCLASSIFIED**

Title: Assessment of Survivability Against Laser Threats - The ASALT-I Computer Program

Issued: September 1981 **DTIC AD #:** A128472
Sponsor: Naval Weapons Center **SURVIAC File #:** 00224
China Lake, CA 93555

Project Engineer: David Hall

Performing Organization: ASI Systems International

Author: Fred J. Steenrod, John E. Musch

Abstract: ASALT-1 is a Fortran computer program used to evaluate the effectiveness of a high-energy laser weapon against an aircraft flying a path previously evaluated for various encounter conditions. The laser weapons system is described by a flux emission function, aiming errors caused by jitter, and slewing limits of the tracking mechanism. The target aircraft is characterized by a set of components which are combined using a fault tree structure. The program output includes a summary for the whole mission which presents probabilities of kill for the total aircraft, its subgroups and components. This manual contains descriptions for the mathematical concepts, the input requirements, and the output for the ASALT-1 program.

LE-6-02 JTCG/AS-79-V-008 **UNCLASSIFIED**

Title: QKLOOK Computer Programs Analyst & User manuals

Issued: April 1980 **DTIC AD #:** B049011
Sponsor: Naval Weapons Center **SURVIAC File #:** 00147L
China Lake, CA 93555

Project Engineer: Carol Gillespie

Performing Organization: ASI Systems International

Author: F. J. Steenrod and J. E. Musch, ASI Systems International

Abstract: QKLOOK is a set of four FORTRAN computer programs which are used to evaluate a target's vulnerability to Directed High Energy Weapons. A target is modeled by describing the geometric shapes of its components and executing a shotline generating program. The weapon is described with intensity levels at various time intervals. QKLOOK is used to simulate the weapon effects along each shotline by computing penetration times for every encounter. The penetration distances at these computed times are used to compute probabilities of kill given a hit, P(K/H), for each component at several time increments based on component critical penetration depths. These probabilities are then used to compute time-increment-dependent vulnerable areas.

The results are expressed as presented and vulnerable areas at each time increment for components, systems of components, and the total target. This document contains information intended for both analysts and users. The first four sections contain technical descriptions of the mathematical concepts, program logic, and source program details. The last three sections contain user-oriented information needed to input the programs and interpret the resulting output.

JTCG/AS-78-S-001 **UNCLASSIFIED**

Title: Surface-to-Air Missile Model - MICE II (Volume I, Analyst Manual)

Issued: 1980 **DTIC AD #:** B047865
Sponsor: JTCG/AS **SURVIAC File #:** 2691

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: P. T. Chan and R. A. Huffman, Vought Corporation

Abstract: This report describes the simulation mechanics of the Missile Intercept Capability Evaluation (MICE II) model. It provides detailed discussion regarding the model's simulation logic, equations of motion, derivation of missile guidance commands, generations of target trajectory, target miss distance calculations, effects of terrain masking, multipath radar angle masking and noise jamming on target acquisition/lock-on, and the effects of noise jamming and target intercept range on target kill probability. The report describes functional characteristics of MICE II subroutines as well as the utilization of block data provided in the model.

JTCG/AS-78-S-001 **UNCLASSIFIED**

Title: Surface-to-Air Missile Model - MICE II (Volume II, User Manual)

Issued: 1980 **DTIC AD #:** B048511

Sponsor: JTCG/AS **SURVIAC File #:** 2798

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division, WPAFB, OH 45433

Author: P. T. Chan and R. A. Huffman, Vought Corporation

Abstract: This report provides a brief description of MICE II capabilities so that the user is aware of options open to him when he employs this surface-to-air missile engagement simulation program. The User Manual includes instructions on the application of simulation controls, input data preparation, internal data updates and printout controls. Sample problems are used to illustrate the program flexibility. Typical data input setups are provided for the simulations so that the user can employ them as a guide to data deck arrangement or as checkouts for user simulation runs.

SA-6-01F **JTCG/AS-77-S-002** **SECRET**
NA-76-917LI

Title: Generic Missile Warheads for use in Aircraft Preliminary Design Hardening Trade Studies (U)

Issued: September 1979 **DTIC AD #:** C019876

Sponsor: JTCG/AS **SURVIAC File #:** 2704

Project Engineer: Gerald Bennett

Performing Organization: Aeronautical Systems Division WPAFB, OH 45433

Author: Brennan, L.M., Darling, W., Prislow, J.

Abstract: (U) This report summarizes the results of a survey and evaluation of the spectrum of enemy surface-to-air and air-to-air nonnuclear missile warheads. This evaluation summarized 30 enemy missile warheads, categorized them, and developed a few generic designs that can be used to represent them in aircraft preliminary design trade studies. The resulting generic warheads are intended to be used for assessment of hardening during the early preliminary design stages when limited time, manpower, and design data are available. The hardness levels derived using these missile warheads are expected to be representative of those that will result during later, more detailed assessments of the designs. This procedure will allow hardening considerations and incorporation of desired hardness levels early in the design cycle. The generic warheads are intended to be used to develop hardening guidelines; they are not intended to be used to accurately represent vulnerability to each specific missile type.

TEAS 5.1.7.2 **JTCG/AS-77-S-001** **UNCLASSIFIED**

Title: An Examination of Selected Digital Flightpath Generators

Issued: November 1977 **DTIC AD #:** A047845L

Sponsor: JTCG/AS **SURVIAC File #:** 1938

Project Engineer: L. C. Hitchcock

Performing Organization: NWSC Division Crane, IN

Author: N. Papke

Abstract: This report describes the findings of an investigative analysis of four flight path generation computer models. The four models (FAIR PASS, FLYGEN, BLUE MAX and MCEP) are commonly used in the aircraft survivability/vulnerability community. The first three are primarily fixed-wing models, while MCEP is exclusively a rotary-wing flight path generator. All four models were acquired, installed, tested, and analyzed at the NWSC. Criteria such as capabilities, limitations, ease and economy of use, and compatibility with attrition models were considered in the evaluations.

SA-6-02 JTCG/AS-76-S-004 **UNCLASSIFIED**

Title: MISDEM Computer Simulation (Volume II, Analyst Manual)

Issued: 1976 **DTIC AD #:** A070991

Sponsor: JTCG/AS **SURVIAC File #:** 2590

Project Engineer: Unknown

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: G. L. Gallien and S. C. Silver, Rockwell Intn'l LA A/C Div.

Abstract: MISDEM is a S/V model that transforms aircraft subsystems probabilities of survival into probabilities of aircraft survivability and probabilities of various aircraft response modes, such as flight, countermeasures, and weapon delivery modes having different degrees of effectiveness. The model may be used to compute measures of effectiveness, such as numbers of targets killed in a mission or a campaign. It is intended for use in measuring the impact of vulnerability of subsystems on aircraft survival and effectiveness for unenhanced or protected subsystems. This analyst manual contains: (1) a description of the mathematical model and its potential applications, (2) a description of the computer code and its derivation, and (3) a listing of the simulation program and test cases used for program verification (which are described in the User Manual).

SA-6-02 JTCG/AS-76-S-003 **UNCLASSIFIED**

Title: MISDEM Computer Simulation (Volume I, User Manual)

Issued: July 1979 **DTIC AD #:** A073490

Sponsor: JTCG/AS **SURVIAC File #:** 2592

Project Engineer: Unknown

Performing Organization: Naval Weapons Center
China Lake, CA 93555

Author: G. L. Gallien and S. C. Silver, Rockwell International

Abstract: The MISDEM (Mission/Damage Effectiveness Model) transforms aircraft subsystem probabilities of survival into probabilities of aircraft modes of response, such as evasion, countermeasures, and weapon survival into probabilities of aircraft modes of response, such as evasion, countemeasures, and weapon delivery modes having different degrees of effectiveness. The model probabilities may then be used in higher order models that compute measures of effectiveness and cost. This user manual contains: (1) a detailed description of the variables required to execute the program and the proper order of the input deck, (2) a detailed description of the output, complete with definitions of the printed data, and (3) a sample case.

SA-6-02 JTCG/AS-76-S-002 **UNCLASSIFIED**

Title: The Mission Trade-Off Methodology (MTOM) Model: User's Manual

Issued: October 1978 **DTIC AD #:** A062947L

Sponsor: JTCG/AS **SURVIAC File #:** 2315

Project Engineer: Unknown

Performing Organization: Aeronautical Systems Division,
WPAFB, OH 45433

Author: A. T. Kearney & Co./Caywood-Schiller Division

Abstract: The MTOM programs provide a means for evaluating the relative cost-effectiveness of proposed aircraft modifications for the purpose of enhancing survivability. The model can treat a wide variety of aircraft and scenarios. There are two programs. One (MTOM) performs the effectiveness analysis. The other (MTO/C) provides the costing. This manual is designed to enable the user to prepare the inputs for the MTOM programs. It covers the overall organization, input formats and restrictions, limitations, and outputs. This document, the MTOM User's Manual, is presented as a companion volume to the Mission Trade-Off Model (MTOM): Model Description, which contains the theory and rationale behind MTOM.

SA-6-02 JTCG/AS-76-S-001 **UNCLASSIFIED**

Title: The Mission Trade-Off Methodology (MTOM) Model: Model Description

Issued: February 1977 **DTIC AD #:** A049318L

Sponsor: JTCG/AS **SURVIAC File #:** 1939

Project Engineer: Unknown

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: A. T. Kearney & Co./ Caywood-Schiller Division

Abstract: Presented are the results, assumptions and rationale of model to evaluate the relative cost-effectiveness of proposed aircraft modifications for survivability enhancement. Two primary questions are addressed. How effective are the proposed modifications in a mission context and what are the important factors contributing to the improvement? To answer these questions, the MTOM model was developed. Parametric variations are presented and analyzed. This report is directed to the analyst who wishes to understand the details of the model. Parametric includes heuristic development of these details.

TEAS 5.1.7.1/3 JTCG/AS-75-S-001 **UNCLASSIFIED**

Title: Error Analysis of Presented Area Computation Techniques

Issued: June 1977 **DTIC AD #:** D702760

Sponsor: JTCG/AS **SURVIAC File #:** 1934

Project Engineer: Smith, R. B.

Performing Organization: Aeronautical Systems Division
WPAFB, OH 45433

Author: Smith, R. B.

Abstract: This report uses the rectangular and ellipsodial projection techniques to convert six cardinal views into 26 views for attrition modeling purposes. Also included are presented area computation techniques.

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A-0-04 JTCG/AS-94-D-004 **UNCLASSIFIED**

Title: JTCG/AS Bibliography of Joint Aircraft Survivability Reports and Related Documents

Issued: July 1994 **DTIC AD #:** N/A

Sponsor: JTCG/AS **SURVIAC File #:** N/A

Project Engineer: LTC John N. Lawless, Jr., USA

Performing Organization: ASI Systems International

Author: Compiled by James A. Buckner, ASI Systems International

Abstract: This bibliography contains abstracts of published JTCG/AS reports and related documents. It is referenced by title and is organized by JTCG/AS Subgroup by year of publication. This issue supersedes all previous issues. A copy may be obtained from the JTCG/AS Central Office.

A-0-04 JTCG/AS-94-D-001 **UNCLASSIFIED**

Title: JTCG/AS Organizational & Specialists Directory

Issued: April 1994 **DTIC AD #:** N/A

Sponsor: JTCG/AS **SURVIAC File #:** N/A

Project Engineer: LTC John N. Lawless, Jr., USA

Performing Organization: ASI Systems International

Author: Compiled by James A. Buckner, ASI Systems International

Abstract: This directory provides the organizational structure of the JTCG/AS, including all Subgroups, and provides a comprehensive listing of specialists in the aircraft survivability engineering discipline. It is hoped that this document will become a much used desk reference for the coordination of aircraft survivability information and technical efforts among and between the government and industry. This issue supersedes all previous issues. A copy may be obtained from the JTCG/AS Central Office.

GP-2-03 JTCG/AS-93-A-002 **UNCLASSIFIED.**
BDM/MCL-93-16238-TR

Title: Human Injury Methodology

Issued: Jan '94 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Maj Dan Sharon

Performing Organization: Aeromedical Systems Division Human Systems Program Office
8107 13th Street
Brooks Air Force Base, TX 78235-5218

Author: Somers, C. E.; LeGrand, C. A.

Abstract: The casualty prediction methodologies currently employed within the Department of Defense (DoD) have been developed as independent efforts and, thus, are often incompatible and inconsistent with each other. To improve the effectiveness of DoD casualty prediction efforts, the Crew Casualty Working Group (CCWG) of the JTCG/ME and JTCG/AS is developing a standard non-nuclear casualty prediction methodology called the Crew Casualty Assessment Process (CCAP). A major feature of the new methodology is that it provides a rigorous separation between the prediction of physical injury to the human and the prediction of the operational and medical consequences of the physical injuries. The portion of CCAP that predicts physical injury to personnel is called the Human Injury Methodology (HIM). The purpose of this development effort is to produce a top level specification for the HIM. The document is organized as follows: Section 1.0 is an introduction to the Human Injury Methodology final report. Section 2.0 of this document describes the research accomplished in this task. The two specifications which produced the HIM top-level specification and the standard injury specification, are included in Section 3.0 & 4.0 respectively. Section 5.0 presents conclusions and recommendations.

GP-5-04 JTCG/AS-92-D-002 **UNCLASSIFIED**

Title: JTCG/AS Administrative Handbook

Issued: April 1992 **DTIC AD #:** N/A

Sponsor: JTCG/AS **SURVIAC File #:** N/A

Project Engineer: John J. Over

Performing Organization: JTCG/AS Central Office

Author: John Over, Joseph Jolley, Philip Weinberg

Abstract: This document has been prepared in order to provide uniform administrative guidance to members of the Joint Technical Coordinating Group on Aircraft Survivability. The JTCG/AS is dedicated to providing a tri-service approach to enhancing the survivability of aircraft. This organization reports to the Joint Aeronautical Commanders Group (JACG). Funding is provided by the Office of the Secretary of Defense. Participants in JTCG/AS projects are required to utilize this manual as their guide in the management and reporting of Research and Development efforts funded through this joint program. This issue supersedes all previous issues. A copy may be obtained from the JTCG/AS Central Office.

JTCG/AS-83-T-002 **Volume I UNCLASSIFIED, Volume II SECRET**

Title: Proceedings of the Conference on Design of Armor Systems (U)

Issued: September 1983 **DTIC AD #:** Not Issued

Sponsor: JTCG/AS **SURVIAC File #:** 03987A thru -88N

Project Engineer: R. A. Horton

Performing Organization: Naval Air Systems Command

Author: Compiled by Irene Dorr, Booz-Allen & Hamilton, Inc.

Abstract: (U) These proceedings cover papers presented at the conference on the design of armor systems. The conference was held at the Naval Postgraduate School, Monterey, CA on 19-21 April 1983. Individual articles from this conference have been entered in the S/V Reference Library at SURVIAC and carry file numbers 03987A through 03988N.

DI-6-03 JTCG/AS-82-D-003, (I-VII) **SECRET**

Title: Proceedings of the Fifth DOD Conference on Laser Vulnerability, Effects and Hardening (U) Volumes I through VII

Issued: 1982 **DTIC AD #:** C953035L

Sponsor: JTCG/AS **SURVIAC File #:** 00230

Project Engineer: R. A. Horton

Performing Organization: Office of Naval Research, Washington, D.C.

Author: Compiled by Irene Door, Booz, Allen & Hamilton, Inc.

Abstract: (U) The 5th DoD Conference on Laser Vulnerability, Effects and Hardening was held 12 - 14 October 1982 at the Naval Postgraduate School, Monterey, CA. Volume I of the proceedings contains the introductory overview papers and the papers from the Vulnerability Session. Individual articles from Volume I have been entered in the SURVIAC Laser Reference Library and carry file numbers 230A through 230T. Volume II of the proceedings contains the Papers on Hardening. Individual articles from Volume II have been entered in the SURVIAC Laser Reference Library and carry file numbers 265A through 265T. Volume III of the proceedings contains the Papers on Strategic Vulnerability and Effects. Individual articles from Volume III have been entered in the SURVIAC Laser Reference Library and carry file numbers 266A through 266Z and 267A. Volume IV of the proceedings contains the Papers on Hardening and Personnel Protection. Individual articles from Volume IV have been entered in the SURVIAC Laser Reference Library and carry file numbers 269A through 269Z and 270 and 270A through 270C. Volume V through VII of the proceedings contains the Session V, VIA, VIB and VII. The papers contained herein carry file numbers 00266A thru 00268A and 00268X.

Aircraft Battle Damage Repair Projects
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A-0-06 JTCG/AS-94-D-002 **UNCLAS**
LMI-JL301RD1

Title: Aircraft Battle Damage Repair (BDR) Analysis Methodology Development Requirements

Issued: 1994 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Joe Jolley

Performing Organization: Logistics Management Institute
2000 Corporate Ridge
McClean, VA 22102-7805

Author: Bruce J. Kaplan, D. Jerry Wallick

Abstract: The JTCG/AS has been asked by the Office of the Secretary of Defense (OSD) to develop and implement a DoD accepted analysis methodology to address BDR aspects of aircraft system design, development, and acquisition. A BDR analysis methodology workshop was conducted to investigate feasible extensions of existing survivability and logistics support analysis methods to include BDR. No methodology obstacles were identified which would preclude such extensions. Industry and government organizations were visited and solicited for specific details on existing methodology limitations that must be addressed to incorporate appropriate BDR considerations. This report summarizes findings from these visits and interviews and documents a recommended roadmap with near-, mid-, and long-term tasks and projects for developing the required BDR analysis capability.

GP-0-02 JTCG/AS-92-D-005 **UNCLAS**
LMI-JL201RD3

Title: Report of Joint Service Aircraft Battle Damage Repair (BDR) Analysis Methodology Workshop

Issued: September 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** 13482

Project Engineer: Joe Jolley

Performing Organization: Logistics Management Institute
2000 Corporate Ridge
McClean, VA 22102-7805

Author: D. Jerry Wallick, Bruce J. Kaplan

Abstract: The first Joint Service Aircraft Battle Damage Repair (BDR) Analysis Methodology Workshop, held 21 – 23 July 1992, was attended by 49 invited speakers and participants. On the basis of the work done in separate sessions on Acquisitions Logistics and System Development/Design and in plenary discussions, it was concluded that, although significant work needs to be done, there are no known methodology obstacles that would preclude proceeding with the process of including BDR in weapon system development. Discussions at the workshop have initiated the definition of interfaces among the various disciplines and agreement on approaches to modify existing methods to account for BDR.

Participants also recommended developing system design guidelines and other educational tools for BDR as critical elements foor incorporating BDR into system design.

GP-0-02 JTCG/AS-92-D-004 **UNCLASSIFIED**
LMI-JL201RD1

Title: Battle Damage Repair Guidelines for the System Acquisition Process

Issued: November 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Joe Jolley

Performing Organization: Logistics Management Institute
2000 Corporate Ridge
McClean, VA 22102-7805

Author: D. Jerry Wallick, Bruce J. Kaplan

Abstract: The overall objective of battle damage repair (BDR) is to return a large number of battle damaged systems to combat readiness quickly. History has shown that the ability to return damaged equipment to combat has been a critical and sometimes decisive factor in successful military campaigns. BDR is only achieved through conscious, thorough consideration of numerous weapon system characteristics throughout the system's acquisition life cycle. This document suggests guidelines for activities and documentation to ensure BDR is explicitly considered in weapon system design, development, test and evaluation, and logistics support.

GP-0-02 JTCG/AS-92-D-003 **UNCLASSIFIED**
LMI-JL201RD2

Title: Research and Development Plan for Aircraft Battle Damage Repair

Issued: June 1992 **DTIC AD #:** Not Issued
Sponsor: JTCG/AS **SURVIAC File #:** Not Issued

Project Engineer: Joe Jolley

Performing Organization: Logistics Management Institute
2000 Corporate Ridge
McClean, VA 22102-7805

Author: D. Jerry Wallick, Bruce J. Kaplan

Abstract: The DoD Battle Damage Repair (BDR) Steering Group, established by the Office of the Under Secretary of Defense for Acquisition, recognized the need for and directed development of this "Research & Development Plan for Aircraft Battle Damage Repair" as the first step in establishing and funding a BDR R&D program. The Aircraft Battle Damage Repair (ABDR) Committee of the JTCG/AS was tasked by the Steering Group Chairman to:

- Assess overall ABDR R&D needs
- Identify and prioritize technology development requirements to meet these needs
- Determine required funding profiles and schedules to accomplish critical ABDR technology development.

This plan represents a one year effort of data gathering from industry and the services, coordination of BDR R&D needs, and documentation of the findings.

LMI-RE801R1 **UNCLASSIFIED**

Title: Battle Damage Repair of Tactical Weapons: An Assessment

Issued: August 1989 **DTIC AD #:** A213117

Sponsor: OUSD(TWP) **SURVIAC File #:** 11283

Project Engineer: Dale Atkinson

Performing Organization: Logistics Management Institute
2000 Corporate Ridge
McClean, VA 22102-7805

Author: Donald W. Srull, Edward D. Sims, Jr., Raymond A. Schaible

Abstract: In this report we describe our findings and conclusions on the U.S. capability to repair battle damaged equipment in the Air Force, Navy and Army. We focus on the tactical fighter aircraft in the Air Force and Navy and ground combat vehicles and helicopters in the Army. Battle Damage Assessment and Repair (BDAR) programs in each Service for research and development, advanced technology, and logistics support are critically analyzed. Finally, we make recommendations for OSD on how the Defense Department's BDAR capability can be enhanced and how OSD can better manage the overall DoD BDAR program.

AFWAL-TR-86-3064, Volume I **UNCLASSIFIED**

Title: Aircraft Battle Damage and Repair Volume I, A Survey of Actual Combat Experience

Issued: August 1986 **DTIC AD #:** B114409L

Sponsor: JTCG/AS **SURVIAC File #:** 8283

Project Engineer: Don Voyls AFWAL-FIEA

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Vice, John M.; Lindenmuth, James R., and Foulk, Jeffrey, The SURVICE Engineering Company

Abstract: During the Southeast Asia conflict, a concerted effort was made to record the details of individual combat damage incidents in which damage or loss occurred to U.S. aircraft. One primary collection method used was on-site data-gathering by Battle Damage Assessment and Reporting Teams (BDART). These teams were operational from July 1969 through September 1971 and, briefly, in December 1972. As a result of the BDART and other data collection activities, a considerable amount of information was gathered documenting the mission scenario, threat, threat effects, damaged systems and subsystems, repair required and, in many cases, photographs depicting the damage and repair.

This report is Volume I of three volumes, which describes the results of a comprehensive review and analysis of selected individual combat damage incident folders from the SURVIAC collection. Volume I gives a pictorial representation of actual combat damage, actual battle damage repair, and a description of the hours, skills and parts needed. Volumes II and III summarize, analyze and present the damage and repair data.

AFWAL-TR-86-3064, Volume II **UNCLASSIFIED**

Title: Aircraft Battle Damage and Repair Volume II, A Summary of ABDR Activity in Southeast Asia

Issued: June 1989 **DTIC AD #:** B137402
Sponsor: JTCG/AS **SURVIAC File #:** 10892

Project Engineer: Don Voyls AFWAL-FIEA

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Vice, John M.; Lindenmuth, James R. ;Foulk, Jeffrey; Keller, Kris of The SURVICE Engineering Company

Abstract: This report, Volume II of three volumes, describes the results of a comprehensive review and analysis of selected individual combat damage incident folders from the SURVIAC collection. This volume summarizes all pertinent damage and repair data and cites several combat damage, actual battle damage repair, and a description of the hours, skills, and parts needed.

AFWAL-TR-86-3064, Volume III **UNCLASSIFIED**

Title: Aircraft Battle Damage and Repair Volume III, A Presentation and Analysis of ABDR Data from Southeast Asia

Issued: August 1990 **DTIC AD #:** B137402
Sponsor: JTCG/AS **SURVIAC File #:** 13641

Project Engineer: Don Voyls AFWAL-FIEA

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Vice, John M.; Lindenmuth, James R. ;Foulk, Jeffrey; Keller, Kris of The SURVICE Engineering Company

Abstract: This report, Volume III of three volumes, provides a presentation and analysis of ABDR information for aircraft representatives of the types currently in the USAF inventory. Emphasis is on categorizing and presenting the data. Patterns and trends were developed relating damage and repair time with the extent of damage, type of threat, aircraft section/location, and aircraft type. The damage and repair data contained in this document are arranged by aircraft and threat. In some cases, threats are grouped together because there was insufficient information to identify the specific threat. Data for miscellaneous and unknown threat types are also presented. The miscellaneous category includes many sources of damage that do not fit the typical enemy threat types; however, because they occurred on the battlefield, they are pertinent to this study. The unknown cases constitute a relatively large block of data, and therefore provide additional and perhaps helpful repair information. The data have been summarized by area of damage, type of damage, internal components damaged, and repair times and techniques. The data for all incidents evaluated have been tabulated and are presented in Appendix A to this Volume.

TC-4-01 JTCG/AS-86-T-002 **UNCLASSIFIED**

Title: Design, Fabrication and Testing of a Battle Damage Repair Kit for "Control-by-Wire" Aircraft

Issued: October 1986 **DTIC AD #:** B111341
Sponsor: JTCG/AS **SURVIAC File #:** 08084

Project Engineer: Tor W. Jansen, NADC (deceased)

Performing Organization: ORFI Systems, Inc.

Author: Adelbert W.Campbell

Abstract: This is a report on the investigation into and development of a land based repair system usable under combat conditions for control-by-wire (CBW) aircraft having sustained ballistic and/or thermal damage to one or more channels of electrical flight control wiring.

Aircraft Survivability Projects (not JTCG/AS funded) Table of Contents

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BRF/DL-2238-Y1 **UNCLASSIFIED**

Title: High Temperature Superconducting Delay Lines & Filterbanks

Issued: April 1993 **DTIC AD #:** Not Issued

Sponsor: Wright Laboratory **SURVIAC File #:** Not Issued

Project Engineer: Neal Fenzi

Performing Organization: Wright Laboratory
Avionics Directorate
WPAFB, OH 45433

Author: Neal Fenzi

Abstract: This report summarizes the technical progress from March 1992 to March 1993 on the High Temperature Superconducting Delay Lines and filterbanks program. The program has two main tasks: 1) to develop a direct radio frequency superconducting switched notch filterbank for use in the front end of wide-band microwave receiver systems to help reduce electromagnetic interface problems on a number of military weapon systems, and 2) to develop a superconducting microwave delay line that possesses good amplitude and phase characteristics. Both applications are intended to exploit the fact that superconducting materials can produce devices with much smaller size, wider bandwidth, lower loss, and higher quality factor than conventional microwave technology aproaches.

FR-A4950 **UNCLASSIFIED**

Title: Digital Infrared Seeker and Missile Simulations (DISAMS) and Related Software

Issued: February 1992 **DTIC AD #:** Not Issued

Sponsor: Naval Research Laboratory **SURVIAC File #:** Not Issued

Project Engineer: Dr. Frank Barone

Performing Organization: Georgia Tech Research Institute
Georgia Institute of Technology
Atlanta, GA 30332

Author: Dr. Frank Barone, NRL sponsored this publication which was published by GTRI under contract #N00014-87-K-2038 - No Report Documentation Page

Abstract: This document describes work performed under contract N00014-87-K-2038 for the Naval Research Laboratory (NRL). The technical monitor was Dr. Frank Barone. This final report is somewhat unusual in that the work it describes was performed primarily under this contract, but relatively small portions of it were supported by other contracts as well. No attempt has been made to separate these contributions because in most cases that would be extremely difficult if not impossible. The software described here is evolutionary in nature. In every case, the initial work was performed for NRL, but improvements have been supported by other government agencies from time to time, and those changes are often further modified with additional NRL support. The document itself is currently used as the User's Manual for the DISAMS (Digital Infrared Seeker And Missile simulation) and ISAMS (Imaging Seeker And Missile Simulation) series of missile models and it, or a specialized modification of it, is delivered with each of the models. As new features are added to the software tools described in the manual, the document is modified to reflect those changes and updates of the relevant portions are provided to users.

WL-TR-92-4039 **UNCLASSIFIED**

Title: Joining and Repair of Heat Resistant Composites

Issued: August 1992 **DTIC AD #:** Not Issued
Sponsor: Wright Laboratory **SURVIAC File #:** Not Issued

Project Engineer: Jerome J. Connolly

Performing Organization: Wright Laboratory
Materials Directorate
WPAFB, OH 45433

Author: Jerome J. Connolly; Mr. Frank Fechek, WL/MLSE

Abstract: This report presents the progress on the Joining and Repair of Heat Resistant Composites Program for the period of April 1989 to March 1992. The program objective is to examine new materials, processes and equipment for their applicabiity to high temperature composite repair development. This interim technical report is primarily concerned with describing accomplishments achieved in Tasks 1 and 2.

BRL-MR-3930 **UNCLASSIFIED**

Title: A Proposed Method for Incorporating Ballistic Shock Effects in Vulnerability/Lethality Analysis

Issued: August 1991 **DTIC AD #:** Not Issued
Sponsor: BRL **SURVIAC File #:** 12320

Project Engineer: James N. Walburt

Performing Organization: Ballistic Research Laboratoy (Renamed Army Research Laboratory)
Aberdeen Proving Ground, MD

Author: James N. Walburt

Abstract: This report describes a proposed method for modeling ballistic shock effects in vulnerability/lethality analyses. A novel approach is described which, under certain simplifying assumptions, can be implemented in a manner entirely compatible with the existing analytical environment.

SURVICE-TR-91-013 **UNCLASSIFIED**

Title: Testing of Aircraft or Aircraft Surrogates with On-Board Munitions

Issued: August 1991 **DTIC AD #:** Not Issued
Sponsor: OUSD DDRE(T&E)/LFT **SURVIAC File #:** 12324

Project Engineer: Michael R. Weisenbach, ASC

Performing Organization: The SURVICE Engineering Company
1003 Old Philadelphia Rd Ste 103
Aberdeen, MD 21001

Author: Foulk, Jeffrey W., Levy, Ronald B., Vikestad, Walter S.

Abstract: This study addresses the need for live fire ballistic testing of aircraft with munitions on board. Current law requires live fire testing of aircraft "configured for combat," which for some aircraft includes a variety of on-board munitions. However, the effect of munitions on aircraft vulnerability is not well quantified. The objectives of this project were to assess the potential benefits of live fire tests of aircraft or aircraft surrogates with live weapons on board, and to develop suggested notional testing schemes. Principal measures of effectiveness (MOE) for assessing aircraft vulnerability were identified. Available data on munitions contribution to aircraft vulnerability, including vulnerability/lethality testing, Southeast Asia combat data, and munitions sensitivity tests, were examined to determine the quantity and quality of the data, and identify gaps or inconsistencies. Vulnerability assessments were then made on three notional aircraft: an air-to-air fighter, an air-to-ground aircraft, and a rotary-wing aircraft. The changes in MOEs when munitions are added were quantified, as well as MOE sensitivity to munitions location, type of threat, and variations in postulated munitions probabilities of kill given a hit. Finally, suggestions were made on the conduct of live fire tests for aircraft with on-board munitions.

WL-TR-91-3025, Vol I Part I **UNCLASSIFIED**

Title: Self-Repairing Flight Control System Volume I: Flight Test Evaluation on an F-15 Aircraft

Issued: August 1991 **DTIC AD #:** Not Issued
Sponsor: Wright Laboratory **SURVIAC File #:** 13474

Project Engineer: Robert Yeager, WL/FIGX

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Urnes, James M.; Hoy, Stephen E.;Wells, Edward A.; Havern, William J.; Norat, Kevin F.; Corvin, John H.

Abstract: The self-repairing flight control system technologies consist of real-time reconfiguration and flight control maintenance diagnostics. A "proof of concept" flight test/demonstration was accomplished on the F-15 Highly Integrated Digital Engine control (HIDEC) airplane at NASA Ames-Dryden, Edwards AFB, CA. This report explains the technologies as developed by General Electric and documents their implementation for flight test. The testing is described and discrepancies between expected and exhibited system performance are analyzed. The effects of reconfiguration of flying/handling qualities are investigated.

WL-TR-91-3025, Vol I Part II **UNCLASSIFIED**

Title: Self-Repairing Flight Control System Volume I: Flight Test Evaluation on an F-15 Aircraft - Appendices

Issued: August 1991 **DTIC AD #:** Not Issued
Sponsor: Wright Laboratory **SURVIAC File #:** 13475

Project Engineer: Robert Yeager, WL/FIGX

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Field, Neil (Ensco); Vancia, Jose (Ensco); Hoy, Stephen; Stifel, Mark (GE); Weiss, Jerald (Alpha Tech); Parkinson, Robert (GE)

Abstract: The self-repairing flight control system technologies consist of real-time reconfiguration and flight control maintenance diagnostics. A "proof of concept" flight test/demonstration was accomplished on the F-15 Highly Integrated Digital Engine control (HIDEC) airplane at NASA Ames-Dryden, Edwards AFB, CA. This appendix contains detailed documentation of the development and adaptation of these technologies to the test airplane for this program.

WL-TR-91-3025, Vol II **UNCLASSIFIED**

Title: Self-Repairing Flight Control System Volume II: Fuselage and Wing Damage Analysis and Development of Control Reconfiguration Concepts

Issued: August 1991 **DTIC AD #:** Not Issued
Sponsor: Wright Laboratory **SURVIAC File #:** 13476

Project Engineer: Robert Yeager, WL/FIGX

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Hoy, Stephen E.; Havern, William J.; Triplett, William E.; Urnes, James M.

Abstract: The aeroelastic effects of battle damage on an F-15 airplane is investigated. Fuselage damage is alleviated, if necessary, by application of a variable notch filter using reconfiguration techniques. Loss of wing span does not lower flutter speed, and some lift loss can be compensated for by the reconfiguration system. Holes in a wing can lower flutter speed depending on the nature of the holes. This report documents the analyses leading to these results.

JLF-TR-88-3 **UNCLASSIFIED**

Title: Ballistic Tests Comparing the Flammabilities of MIL-H-5606 and MIL-H-83282 Hydraulic Fluids

Issued: December 1990 **DTIC AD #:** Not Issued
Sponsor: ODDDRE(T&E)/LFT **SURVIAC File #:** 12626

Project Engineer: Capt. Hagop Jibilian

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Jibilian, Hagop Capt.; Benjamin, Richard Ph.D.

Abstract: Ballistic testing of MIL-H-5606 and MIL-H-83282 hydraulic fluids was conducted in a 3000 psi hydraulic system housed in a simulated dry bay. Airflow was directed over the test article at either 475 knots to simulate flight, or 0 knots to simulate a parked aircraft. A Soviet 23-mm HEI-T projectile impacted the test article at approximately 2400 feet per second. A total of 128 shots was completed successfully. Airflow was observed to have a pronounced effect upon test outcomes. Under 0 knot conditions, MIL-H-5606 hydraulic fluid fires burned statistically longer and resulted in higher dry bay temperatures than MIL-H-83282. Under 475 knot airflow conditions, MIL-H-83282 fires burned statistically longer and resulted in statistically higher dry bay temperatures than MIL-H-5606.

NWC TM 7685 **UNCLASSIFIED**

Title: Reduction of Fuel Ingestion Vulnerability of the F/A-18 Aircraft, an Interim Report

Issued: September 1990 **DTIC AD #:** Not Issued
Sponsor: NAVAIR **SURVIAC File #:** Not Issued

Project Engineer: Gary Burgner

Performing Organization: Naval Air Warfare Center Weapons Division
China Lake, CA 93555-6001

Author: Gary Burgner and G. Philip Dixon, Code 3183, NWC

Abstract: (U) This report documents the analysis and testing done to identify the most appropriate materials and installation locations required to protect the F/A-18 engine bay from fires resulting from both inlet fuel ingestion in combat and fires that have plaqued the aircraft in peacetime operations. Vulnerability tests of the F/A-18 conducted at the Naval Weapons Center, China Lake, CA in 1987 dramatically point out the potential for loss of the aircraft due to inlet fuel ingestion by only one engine. A sufficiently large ingestant flow will ignite in the afterburner and burn a large hole in the case. From this hole will issue a large and hot torch, which tends to blast through the airframe structure and beyond, and generally diffuse throughout the engine bay. The only solution known to be effective and immediately available is to protect the engine bay structure with an insulating or ablative thermal protection material.

AFWAL-TR-87-3114 **CONFIDENTIAL**

Title: FASTGEN/COVART Sensitivity Study (U)

Issued: February 1988 **DTIC AD #:** C043490

Sponsor: Wright Laboratory **SURVIAC File #:** 9561

Project Engineer: Gerald Bennett, AFWAL/FIEST

Performing Organization: Wright Laboratory
Flight Dynamics Directorate
WPAFB, OH 45433

Author: Andrew M. Pascal

Abstract: (U) The use of analytical vulnerability assessments in quantifying the vulnerability of aircraft in combat and for providing inputs into survivability assessments of aircraft is an accepted procedure and plays a major role in the development and acquisition of USAF weapon systems. One such method, known as the FASTGEN/COVART methodology is used to determine an aircraft's vulnerability expressed in terms of vulnerable area. The work discussed in this report is concerned with a sensitivity study to determine how and to what degree the different inputs affect the generated vulnerable area. The results of this sensitivity study form the basis for development of a plan to improve both the use of the COVART methodology and the methodology itself. A comparison between analytically and empirically derived vulnerable areas was to validate the FASTGEN/COVART methodology.

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